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CLASS 11
PHYSICS

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## WORK ENERGY AND POWER

1. The decrease in the potential energy of a ball of mass 20 kg which falls from a height of 50 cm is
   a) 968 J
   b) 98 J
   c) 1980 J
   d) None of these

2. The potential energy of a certain spring when stretched through a distance 'S' is 10 $joule$. The amount of work (in joule) that must be done on this spring to stretch it through an additional distance 'S' will be
   a) 30
   b) 40
   c) 10
   d) 20

3. One man takes 1 minute to raise a box to a height of 1 m and another man takes $\frac{1}{2}$ minute to do so. The energy of the two is
   a) Different
   b) Same
   c) Energy of the first is more
   d) Energy of the second is more

4. The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is $D = [U(x = \infty) - U_{\text{at equilibrium}}]$, D is
   a) $\frac{b^2}{6a}$
   b) $\frac{b^2}{2a}$
   c) $\frac{b^2}{12a}$
   d) $\frac{b^2}{4a}$

5. If the kinetic energy of a body is increased 2 times , its momentum will
   a) Half
   b) Remain unchanged
   c) Be doubled
   d) increase $\sqrt{2}$ times

6. A steel ball of radius 2 cm is at rest on a frictionless surface. Another ball of radius 4 cm moving at a velocity of 81 cm/sec collides elastically with first ball. After collision the smaller ball moves with speed of
   a) 81 cm/sec
   b) 63 cm/sec
   c) 144 cm/sec
   d) None of these

7. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m, find the correct relation between W_1, W_2 and W_3

   a) $W_1 > W_2 > W_3$
   b) $W_1 = W_2 = W_3$
   c) $W_1 < W_2 < W_3$
   d) $W_2 > W_1 > W_3$
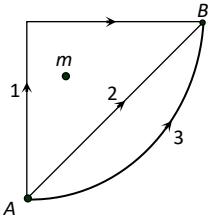
8. Two putty balls of equal mass moving with equal velocity in mutually perpendicular directions, stick together after collision. If the balls were initially moving with a velocity of $45\sqrt{2}\ ms^{-1}$ each, the velocity of their combined after collision is
   a) $45\sqrt{2}\ ms^{-1}$
   b) $45\ ms^{-1}$
   c) $90\ ms^{-1}$
   d) $22.5\sqrt{2}\ ms^{-1}$

9. A man does a given amount of work in 10 s. Another man does the same amount of work in 20 s. The ratio of the output power of first man to the second man is
   a) 1
   b) $\frac{1}{2}$
   c) $\frac{2}{1}$
   d) None of these

10. The force constant of a wire is k and that of another wire is $2k$. When both the wires are stretched through same distance, then the work done
    a) $W_2 = 2W_1^2$
    b) $W_2 = 2W_1$
    c) $W_2 = W_1$
    d) $W_2 = 0.5W_1$

11. The potential energy of a particle in a force field is $U = \frac{A}{r^2} - \frac{B}{r}$, where A and B are positive constants and r is the distance of particle from the centre of the field. For stable equilibrium, the distance of the particle is
    a) $B/2A$
    b) $2A/B$
    c) A/B
    d) B/A

12. Consider the following statements. A and B and identify the correct answer given below.
    I. Body initially at rest is acted upon by a constant force. The rate of change of its kinetic energy varies linearly with time.
    II. When a body is at rest, it must be in equilibrium.

a) A and B are correct

b) A and B are wrong

c) A is correct and B is wrong

d) A is wrong and B is correct

13. A body at rest breaks into two pieces with unequal mass
    a) Both of them have equal speeds
    b) Both of them move along a same line with unequal speeds
    c) Sum of their momentum is non zero
    d) They move along different lines with different speeds

14. A mass of 50 kg is raised through a certain height by a machine whose efficiency is 90%, the energy is 5000 J. If the mass is now released, its KE on hitting the ground shall be
    a) 5000 J
    b) 4500 J
    c) 4000 J
    d) 5500 J

15. A body of mass 2 kg is projected at 20 m/s at an angle of 60°above the horizontal. Power on the block due to the gravitational force at its highest point is
    a) 200 W
    b) 100$\sqrt{3}$ W
    c) 50 W
    d) Zero

16. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine
    a) 800 W
    b) 400 W
    c) 200 W
    d) 100 W

17. A particle free to move along the x-axis has potential energy given by $U(x) = k[1 - \exp(-x^2)]$for $-\infty \le x \le +\infty$, where k is a positive constant of appropriate dimensions. Then
    a) At point away from the origin, the particle is in unstable equilibrium
    b) For any finite non-zero value of x, there is a force directed away from the origin
    c) If its total mechanical energy is $k/2$, it has its minimum kinetic energy at the origin
    d) For small displacements from $x = 0$, the motion is simple harmonic

18. The relation between the displacement$X$ of an object produced by the application of the variable force F is represented by a graph shown in the figure. If the object undergoes a displacement from $X = 0.5\ m$ to $X = 2.5\ m$ the work done will be approximately equal to
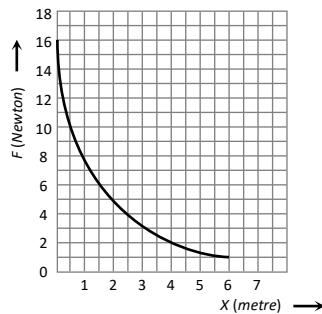
a) 16 J
b) 32 J
c) 1.6 J
d) 8 J

19. Two rectangular blocks A and B of masses 2kg and 3 kg respectively are connected by spring of spring constant 10.8 Nm^{-1}and are placed on a frictionless horizontal surface. The block A was given an initial velocity of 0.15 ms^{-1} in the direction shown in the figure. The maximum compression of the spring during the motion is
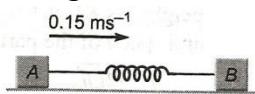
a) 0.01 m
b) 0.02 m
c) 0.05 m
d) 0.03 m

20. A force of 5N, making an angle θ with the horizontal, acting on an object displaces it by 0.4m along the horizontal direction. If the object gains kinetic energy of 1J, the horizontal component of the force is
    a) 1.5 N
    b) 2.5 N
    c) 3.5 N
    d) 4.5 N

21. The bodies of masses 1 kg and 5 kg are dropped gently from the top of a tower. At a point 20 cm from the ground, both the bodies will have the same
    a) Momentum
    b) Kinetic energy
    c) Velocity
    d) Total energy

22. A 10 $H.P.$ motor pumps out water from a well of depth 20m and fills a water tank of volume 22380 $litres$ at a height of 10 m from the ground. The running time of the motor to fill the empty water tank is ($g = 10ms^{-2}$)

a) 5 $minutes$ b) 10 $minutes$ c) 15 $minutes$ d) 20 $minutes$

23. Power of water pump is 2 kW. If $g = 10 \ m/sec^2$, the amount of water it can raise in one minute to a height of 10 m is
    a) 2000 $litre$ b) 1000 $litre$ c) 100 $litre$ d) 1200 $litre$

24. A rubber ball is dropped from a height of 5 m on a planet where the acceleration due to gravity is not known. On bouncing, it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of
    a) 16/25   b) 2/5   c) 3/5   d) 9/25

25. A coolie 1.5 m tall raises a load of 80 kg in 2 s from the ground to his head and then walks a distance of 40 m in another 2 s. The power developed by the coolie is [g $= 10$ ms^{-2}]
    a) 0.2 kW   b) 0.4 kW   c) 0.6 kW   d) 0.8 kW

26. A bomb at rest explodes into 3 parts of the same mass.
    The momentum of the 2 parts is $-2p\hat{I}$ and $p\hat{j}$. The momentum of the third part will have a magnitude of
    a) p b) $\sqrt{3p}$ c) $p\sqrt{5}$ d) zero

27. The potential energy of a certain spring when stretched through a distance s is 10 J. The amount of work (in joule) that must be done on this spring to stretch it through additional distance s will be
    a) 30   b) 40   c) 10   d) 20

28. A particle of mass m moving with horizontal speed 6 m/sec as shown in figure. If $m << M$ than for one dimensional elastic collision, the speed of lighter particle after collision will be

    a) $2m/sec$ in original direction   b) $2m/sec$ opposite to the original direction
    c) $4m/sec$ opposite to the original direction   d) $4m/sec$ in original direction

29. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the stuck particle move in directions making angles θ_1 and θ_2 respectively with the initial direction of motion.
    The sum of the angles $\theta_1 + \theta_2$
    a) 45°   b) 90°   c) 135°   d) 180°

30. A car weighing 1400 kg is moving at a speed of 54 kmh^{-1} up a hill when the motor stops. If it is just able to reach the destination which is at a height of 10 m above the point, then the work done against friction (negative of the work done by the friction) is [Take g $= 10$ms^{-2}]
    a) 10 kJ   b) 15 kJ   c) 17.5 kJ   d) 25 kJ

31. A bomb is kept stationary at a point. It suddenly explodes into two fragments of masses 1g and 3g. The total K.E. of the fragments is $6.4 \times 10^4 \ J$. What is the K.E. of the smaller fragment
    a) $2.5 \times 10^4 \ J$ b) $3.5 \times 10^4 \ J$ c) $4.8 \times 10^4 \ J$ d) $5.2 \times 10^4 \ J$

32. If the heart pushes 1 cc of blood in 1 s under pressure 20000Nm^{-2}, the power of heart is
    a) 0.02 W   b) 400 W   c) 5$\times 10^{-10}$W   d) 0.2 W

33. The energy required to accelerate a car from 10 m/s to 20 m/s is how many times the energy required to accelerate the car from rest to 10 m/s
    a) Equal   b) 4 times   c) 2 times   d) 3 times

34. A uniform chain of length L and mass M is lying on a smooth table and one third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, the work required to pull the hanging part on to the table is
    a) MgL b) $MgL/3$ c) $MgL/9$ d) $MgL/18$

35. When a 1.0 kg mass hangs attached to a spring of length 50 cm, the spring stretches by 2 cm. The mass is pulled down until the length of the spring becomes 60 cm. What is the amount of elastic energy stored in the spring in this condition, if $g = 10 \ m/s^2$
    a) 1.5 $joule$ b) 2.0 $joule$ c) 2.5 $joule$ d) 3.0 $joule$

36. A mass m is attached to the end of a rod of length l. The mass goes around a vertical circular path with the other end hinged at the centre. What should be the minimum velocity of mass at the bottom of the circle, so that the mass complete the circle?

a) $\sqrt{4gl}$ b) $\sqrt{3gl}$ c) $\sqrt{5gl}$ d) $\sqrt{gl}$

37. A bullet of mass a and velocity b is fired into a large block of mass c. The final velocity of the system is

a) $\dfrac{c}{a+b}.b$ b) $\dfrac{a}{a+c}.b$ c) $\dfrac{a+b}{c}.a$ d) $\dfrac{a+c}{a}.b$

38. A bomb of mass M at rest explodes into two fragments of masses m_1 and m_2. The total energy released in the explosion is E. If E_1 and E_2 represent the energies carried by masses m_1 and m_2 respectively, then which of the following is correct?

a) $E_1 = \dfrac{m_2}{M}E$ b) $E_1 = \dfrac{m_1}{m_2}E$ c) $E_1 = \dfrac{m_1}{M}E$ d) $E_1 = \dfrac{m_2}{m_1}E$

39. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in directions making angles θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angles $\theta_1 + \theta_2$, is

a) 45°   b) 90°   c) 135°   d) 180°

40. The force F acting on a particle moving in a straight line is shown in figure. What is the work done by the force on the particle in the 1st meter of the trajectory
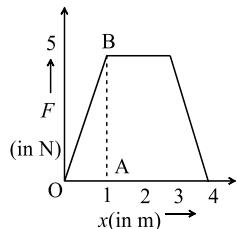
a) 5 J   b) 10 J   c) 15 J   d) 2.5 J

41. Two springs have force constants k_1 and k_2. There are extended through the same distance x. If their elastic energies are E_1 and E_2, then $\dfrac{E_1}{E_2}$ is equal to

a) $k_1 : k_2$ b) $k_2 : k_1$ c) $\sqrt{k_1} : \sqrt{k_2}$ d) $k_1^2 : k_2^2$

42. A position dependent force $F = 7 - 2x + 3x^2 \, newton$ acts on a small body of mass 2 kg and displaces it from $x = 0$ to $x = 5m$. The work done in $joules$ is

a) 70   b) 270   c) 35   d) 135

43. An automobile weighing 1200 kg climbs up a hill that rises 1 m in 20 s. Neglecting frictional effects. The minimum power developed by the engine is 9000 W. If g = 10ms^{-2}, then the velocity of the automobile is

a) 36 km h^{-1} b) 54 km h^{-1} c) 72 km h^{-1} d) 90 km h^{-1}

44. A mass of M kg suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45^0 with the initial vertical direction is

a) $Mg(\sqrt{2} + 1)$ b) $Mg\sqrt{2}$ c) $\dfrac{Mg}{\sqrt{2}}$ d) $Mg(\sqrt{2} - 1)$

45. A body of mass 10 kg is moving on a horizontal surface by applying a force of 10 N in forward direction. If body moves with constant velocity, the work done by force of fiction for a displacement of 2m is

a) -20 J   b) 10 J   c) 20 J   d) -5 J

46. The pointer reading v/s load graph for a spring balance is as given in the figure. The spring constant is
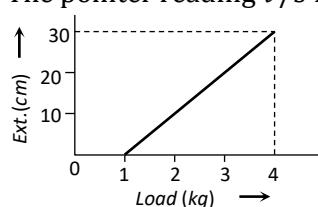
a) $0.1 \, kg/cm$ b) $5 \, kg \, cm$ c) $0.3 \, kg/cm$ d) $1 \, kg/cm$

47. A ball dropped from a height of $2m$ rebounds to a height of $1.5 \, m$ after hitting the ground. Then the percentage of energy lost is

a) 25   b) 30   c) 50   d) 100

48. Two particles having position vectors $\vec{r_1} = (3\hat{\imath} + 5\hat{\jmath}) \, metres$ and $\vec{r_2} = (-5\hat{\imath} - 3\hat{\jmath}) \, metres$ are moving with velocities $\vec{v_1} = (4\hat{\imath} + 3\hat{\jmath})m/s$ and $\vec{v_2} = (\alpha\hat{\imath} + 7\hat{\jmath})m/s$. If they collide after 2 seconds, the value of 'α' is

a) 2   b) 4   c) 6   d) 8

49. Which of the following statements is wrong?
   a) KE of a body is independent of the direction of motion
   b) In an elastic collision of two bodies ,the momentum and energy of each body is conserved
   c) If two protons are brought towards each other the PE of the system decreases.
   d) A body cannot have energy without momentum.

50. Which of the following graphs show variation of potential energy (U) with position x.

a)

b)

c)

d)
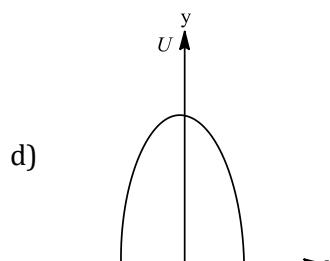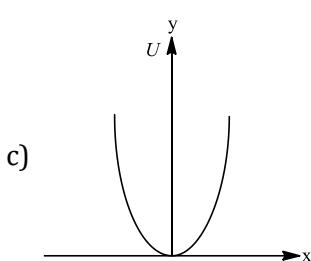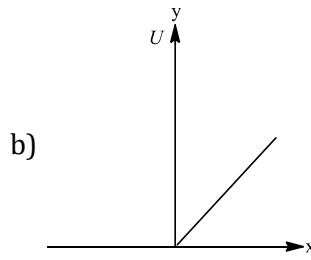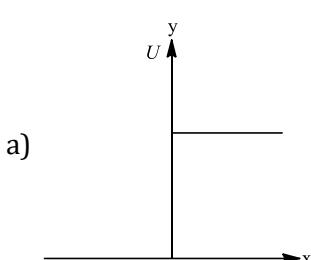
51. A ball is released from certain height. It loses 50% of its kinetic energy on striking the ground. It will attain a height again equal to
   a) One fourth the initial height   b) Half the initial height
   c) Three fourth initial height   d) None of these

52. A rope ladder with a length l carrying a man with a mass m at its end is attached to the basket of balloon with a mass M. The entire system is in equilibrium in the air. As the man climbs up the ladder into the balloon, the balloon descends b y a height h. Then the potential energy of the man
   a) Increase by $mg(l - h)$ b) Increase by mgl
   c) Increases by mgh d) Increases by $mg(2l - h)$

53. A particle is projected at 60° to the horizontal with a kinetic energy K. The kinetic energy at the highest point is
   a) K b) Zero   c) $\dfrac{K}{4}$ d) $\dfrac{K}{2}$

54. A 10 kg object collides with stationary 5 kg object and after collision they stick together and move forward with velocity 4 ms^{-1}.what is the velocity with which the 10 kg object hit the second one?
   a) 4 ms^{-1} b) 6 ms^{-1} c) 10 ms^{-1} d) 12 ms^{-1}

55. A force $F = Ay^2 + By + C$ acts on a body in the y-direction. The work done by this force during a displacement from $y = -a$ to $y = a$ is
   a) $\dfrac{2Aa^3}{3}$ b) $\dfrac{2Aa^3}{3} + 2Ca$ c) $\dfrac{2Aa^3}{3} + \dfrac{Ba^2}{2} + Ca$ d) None of these

56. The kinetic energy possessed by a body of mass m moving with a velocity v is equal to $1/2\ mv^2$, provided
   a) The body moves with velocities comparable to that of light
   b) The body moves with velocities negligible compared to the speed of light
   c) The body moves with velocities greater than that of light
   d) None of the above statement is corrects

57. Which of the following graphs is correct between kinetic energy (E), potential energy (U) and height (h) from the ground of the particle

a)

b)

c)

d)
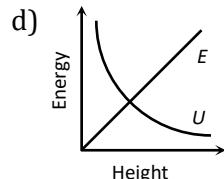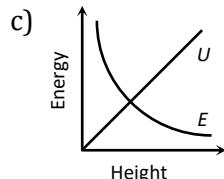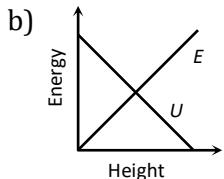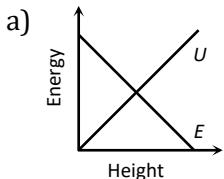
58. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10,000 N/m. The spring compresses by

a) 5.5 cm b) 2.5 cm c) 11.0 cm d) 8.5 cm

59. Quantity/Quantities remaining constant in a collision is/are

a) Momentum, kinetic energy and temperature

b) Momentum but not kinetic energy and temperature

c) Kinetic energy and temperature but not momentum

d) None of the above

60. A force $\mathbf{F} = (2\hat{\imath} + 4\hat{\jmath})$N displaces the body by $\boldsymbol{s} = (3\hat{\jmath} + 5\widehat{\boldsymbol{k}})$m in 2 s. Power generated will be

a) 11 W   b) 6 W   c) 22 W   d) 12 W

61. A billiards player hits a stationary ball by an identical ball to pocket the target ball in a corner pocket that is at an angle of 35° with respect to the direction of motion of the first ball. Assuming the collision as elastic and that friction and rotational motion are not important, the angle made by the target ball with respect to the incoming ball is

a) 35°   b) 50°   c) 55°   d) 60°

62. A machine which is 75% efficient uses 12 J of energy in lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through, that distance. The velocity of the ball at the end of its fall is

a) $\sqrt{24}$ ms^{-1} b) $\sqrt{32}$ ms^{-1} c) $\sqrt{18}$ ms^{-1} d) 3 ms^{-1}

63. A car manufacturer claims that his car can be accelerated from rest to a velocity of 10 ms^{-1} in 5 s. If the total mass of the car and its occupants is 1000 kg, then the average horse power developed by the engine is

a) $\dfrac{10^3}{746}$ b) $\dfrac{10^4}{746}$ c) $\dfrac{10^5}{746}$ d) 8

64. A body of mass M moves with velocity v and collides elastically with a another body of mass $m(M \gg m)$ at rest then the velocity of body of mass m is

a) v b) $2v$ c) $v/2$ d) Zero

65. A particle, initially at rest on a frictionless horizontal surface, is acted upon by a horizontal force which is constant in size and direction. A graph is plotted between the work done (W) on the particle, against the speed of the particle, (v). If there are no other horizontal forces acting on the particle the graph would look like

a) w

v

b) w

v

c) w

v

d) w

v

66. A body of mass 50 kg is projected vertically upwards with velocity of 100 m/sec. 5 seconds after this body breaks into 20 kg and 30 kg. If 20 kg piece travels upwards with 150 m/sec, then the velocity of the block will be

a) 15 m/sec downwards   b) 15 m/sec upwards

c) 51 m/sec downwards   d) 51 m/sec upwards

67. A man, by working a hand pump fixed to a well, pumps out 10 m^{3}water in 1 s. If the water in the well is 10 m below the ground level, then the work done by the man is (g = 10ms^{-2})

a) 10^3J   b) 10^4J   c) 10^5J   d) 10^6J

68. A body of mass m_1 is moving with a velocity V. It collides with another stationary body of mass m_2. They get embedded. At the point of collision, the velocity of the system

a) Increases

b) Decreases but does not become zero

c) Remains same

d) Become zero

69. An intense stream of water of cross-sectional area A strikes a wall at an angle θ with the normal to the wall and returns back elastically. If the density of water is ρ and its velocity is v, then the force exerted in the wall will be
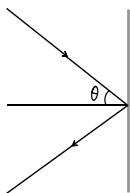
a) $2Av\rho \cos\theta$ b) $2Av^2\rho \cos\theta$ c) $2Av^2\rho$ d) $2Av\rho$

70. Two solid rubber balls A and B having masses 200 and 400 g respectively are moving in opposite directions with velocity of A equal to 0.3 m/s. After collision the two balls come to rest, then the velocity of B is

a) 0.15 m/sec b) 1.5 m/sec c) $-0.15\ m/sec$ d) None of the above

71. A space craft of mass M and moving with velocity v suddenly breaks in two pieces of same mass m. After the explosion one of the mass m becomes stationary. What is the velocity of the other part of craft?

a) $\dfrac{Mv}{M-m}$ b) V c) $\dfrac{Mv}{m}$ d) $\dfrac{M-m}{m}v$

72. A force $\mathbf{F} = -K(y\mathbf{i} + x\mathbf{j})$ (where K is a positive constant) acts on a particle moving in the xy-plane. Starting from the origin, the particle is taken along the positive x-axis to the point $(a, 0)$ and then parallel to the y-axis to the point (a, a). The total work done by the force F on the particles is

a) $-2\ Ka^2$ b) $2Ka^2$ c) $-Ka^2$ d) Ka^2

73. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It slides down a smooth surface to the ground, then climbs up another hill of height 30 m and finally slides down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

a) 10 m/s b) $10\sqrt{30}\ m/s$ c) 40 m/s d) 20 m/s

74. Adjacent figure shows the force-displacement graph of a moving body, the work done in displacing body from $x = 0$ to $x = 35\ m$ is equal to
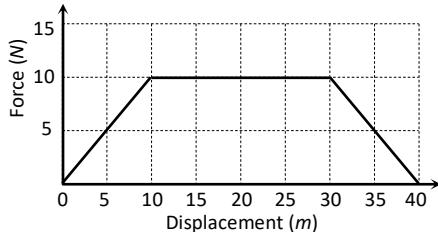
a) 50 J b) 25 J c) 287.5 J d) 200 J

75. A bomb is kept stationary at a point. It suddenly explodes into two fragments of masses 1g and 3g. The total KE of the fragments is 6.4×10^4 J. What is the KE of the smaller fragment?

a) 2.5×10^4 J b) 3.5×10^4 J c) 4.8×10^4 J d) 5.2×10^4 J

76. What is the velocity of the bob of a simple pendulum at its mean position, if it is able to rise to vertical height of 10 cm (Take $g = 9.8\ m/s^2$)
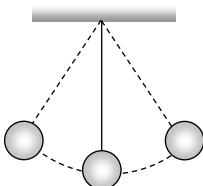
a) 0.6 m/s b) 1.4 m/s c) 1.8 m/s d) 2.2 m/s

77. Which of the following statements are incorrect?

(i) If there were no friction, Work need to be done to move a body up an inclined plane is zero.

(ii) If there were no friction, moving vehicles could not be stopped even by locking the brakes.

(iii)As the angle of inclination is increased, the normal reaction on the body placed on it increases.
(iv)A duster weighing 0.5 kg is pressed against a vertical board with a force of 11 N. If the coefficient of friction is 0.5, the work done in rubbing it upward through a distance of 10 cm is 0.55J.

a) (i)and(ii)   b) (i),(ii),(iv)   c) (i),(iii),and(iv)   d) All of these

78. A ^{238}U nucleus decays by emitting an alpha particle of speed $v\ ms^{-1}$. The recoil speed of the residual nucleus is (in ms^{-1})

a) $-4v/234$ b) $v/4$ c) $-4v/238$ d) $4v/238$

79. A body of mass 5 kg is placed at the origin, and can move only on the x-axis. A force of 10 N is acting on it in a direction making an angle of 60° with the x-axis and displaces it along the x-axis by 4 $metres$. The work done by the force is

a) 2.5 J b) 7.25 J c) 40 J d) 20 J

80. The potential energy of a 1 kg particle free to move along the x-axis is given by

$$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{4}\right)J$$

The total mechanical energy of the particle is 2J. Then, the maximum speed (in m/s) is

a) $\sqrt{2}$ b) $1/\sqrt{2}$ c) 2   d) $3/\sqrt{2}$

81. If the unit of force and length each be increased by four times, then the unit of energy is increased by

a) 16 times   b) 8 times   c) 2 times   d) 4 times

82. A billiard ball moving with a speed of 5 m/s collides with an identical ball originally at rest. If the first ball stops after collision, then the second ball will move forward with a speed of

a) 10 ms^{-1} b) 5 ms^{-1} c) 2.5 ms^{-1} d) 1.0 ms^{-1}

83. A body of mass 5 kg is thrown vertically up with a kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of the original value is

a) 12.5m   b) 10m   c) 2.5m   d) 5m

84. A 0.5 kg ball is thrown up with an initial speed 14 m/s and reaches a maximum height of 8.0m. How much energy is dissipated by air drag acting on the ball during the ascent

a) 19.6 $Joule$ b) 4.9 $Joule$ c) 10 $Joule$ d) 9.8 $Joule$

85. A particle is released from a height s. At certain height its kinetic energy is three times its potential energy. The height and speed of the particle at that instant are respectively

a) $\frac{s}{4}, \frac{3gs}{2}$ b) $\frac{s}{4}, \frac{\sqrt{3gs}}{2}$ c) $\frac{s}{2}, \frac{\sqrt{3gs}}{2}$ d) $\frac{s}{4}, \frac{\sqrt{3gs}}{2}$

86. A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 ft tall building .After a fall of 30 ft each towards earth ,their respective kinetic energies will be in the ratio of

a) $\sqrt{2}:1$ b) 1:4   c) 1:2   d) 1:$\sqrt{2}$

87. When a spring is stretched by 2 cm, it stores 100 J of energy. If it is stretched further by 2 cm, the stored energy will be increased by

a) 100 J b) 200 J c) 300 J d) 400 J

88. A body of mass 2 kg is projected at $20ms^{-1}$ at an angle 60° above the horizontal. Power Due to the gravitational force at its heights point is

a) 200 W   b) $100\sqrt{3}W$ c) 50 W   d) Zero

89. A 10kg mass moves along x-axis. Its acceleration as a function of its position is shown in the figure. What is the total work done on the mass by the force as the mass moves from $x = 0$ to $x = 8\ cm$
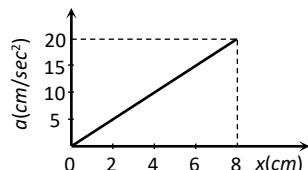

a) $8 \times 10^{-2}\ joules$ b) $16 \times 10^{-2}\ joules$ c) $4 \times 10^{-4}\ joules$ d) $1.6 \times 10^{-3}\ joules$

90. A shell of mass m moving with velocity v suddenly breaks into 2 pieces. The part having mass $m/4$ remains stationary. The velocity of the other shell will be

a) v b) $2v$ c) $\dfrac{3}{4}v$ d) $\dfrac{4}{3}v$

91. A light and a heavy body have equal kinetic energy.Which one has a greater momentum
    a) The light body
    b) The heavy body
    c) Both have equal momentum
    d) It is not possible to say anything without additional information

92. Two bodies A and B have masses 20 kg and 5 kg respectively .Each one is acted upon by a force of 4 kg-wt. If they acquire the same kinetic energy in times t_A and t_B, then the ration $\dfrac{t_A}{t_B}$ is

    a) $\dfrac{1}{2}$ b) 2   c) $\dfrac{2}{5}$ d) $\dfrac{5}{6}$

93. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12kg.The velocity of 18 kg mass is $6\ ms^{-1}$.The kinetic energy of the other mass is
    a) 256 J   b) 486 J   c) 524 J   d) 324 J

94. The graph between $\sqrt{E}$ and $1/p$ is (E =kinetic energy and $p = $ momentum)

    a)   b)   c)   d)
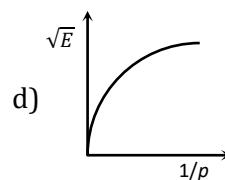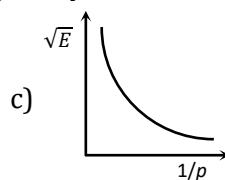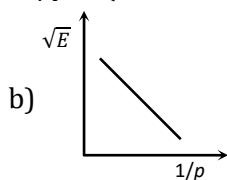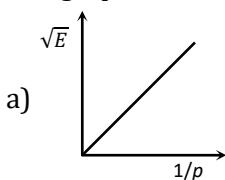
95. A bag (mass M) hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined (bag + bullet) system
    a) Momentum is $\dfrac{mvM}{M+m}$
    b) Kinetic energy is $\dfrac{mv^2}{2}$
    c) Momentum is $\dfrac{mv(M+m)}{M}$
    d) Kinetic energy is $\dfrac{m^2v^2}{2(M+m)}$

96. The kinetic energy k of a particle moving along a circle of radius R depends upon the distance s as $k = as^2$. The force acting on the particle is

    a) $2a\dfrac{s^2}{R}$ b) $2as\left[1+\dfrac{s^2}{R^2}\right]^{1/2}$ c) $2as$ d) $2a$

97. If the linear momentum is increased by 50%, then kinetic energy will be increased by
    a) 50%   b) 20%   c) 125%   d) None of these

98. A shell of mass 200 gm is ejected from a gun of mass 4 kg by an explosion that generates 1.05 kg of energy. The initial velocity of the shell is
    a) $40\ ms^{-1}$ b) $120\ m^{-1}$ c) $100\ ms^{-1}$ d) $80\ ms^{-1}$

99. A block(B) is attached to two unstretched springs S_1 and S_2 with springs constants k and $4k$,representively (see Fig. I)The other ends are attached to identical supports M_1 and M_2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall I by small distance x(Fig II) and released. The block returns and moves a maximum distance y towards wall 2.Displacements x and y are measured with respect to the equilibrium position of the block B The ratio $\dfrac{y}{x}$ is
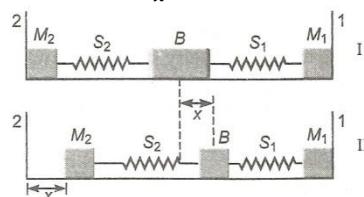

    a) 4   b) 2   c) $\dfrac{1}{2}$ d) $\dfrac{1}{4}$

100. A body of mass m moving with velocity v collides head on another body of mass $2m$ which is initially at rest. The ratio of KE of colliding body before and after collision body before and after collision will be

a) 1:1   b) 2:1   c) 4:1   d) 9:1

101. A ball moving with velocity 2 m/s. collides head on with another stationary ball of double the mass. If the coefficient of restitution is 0.5, then their velocities (in m/s) after collision will be

a) 0,2   b) 0, 1   c) 1, 1   d) 1, 0.5

102. A block of mass $5kg$ is resting on a smooth surface. At what angle a force of $20N$ be acted on the body so that it will acquired a kinetic energy of $40J$ after moving $4m$

a) 30°   b) 45°   c) 60°   d) 120°

103. A 50g bullet moving with a velocity of 10 ms^{-1} gets embeded into a 950g stationary body. The loss in KE of the system will be

a) 95%   b) 100%   c) 5%   d) 50%

104. A long spring, when stretched by x cm has a potential energy U. On increasing the length of spring by stretching to nx cm, the potential energy stored in the spring will be

a) $\dfrac{U}{n}$ b) nU c) n^2U d) $\dfrac{U}{n^2}$

105. When a force is applied on a moving body, its motion is retarded. Then the work done is

a) Positive   b) Negative   c) Zero   d) Positive and negative

106. If a body of mass 3 kg is dropped from the top of a tower of height 25 m, then its kinetic energy after 3 s will be

a) 1126 J   b) 1048 J   c) 735 J   d) 1296 J

107. A spring of force constant 800 N/m has an extension of $5cm$. The work done in extending it from 5 cm to 15 cm is

a) 16 J b) 8 J c) 32 J d) 24 J

108. A body moving with a velocity v,breaks up into two equal parts. One of the part retraces back with velocity v.Then, the velocity of the other part is

a) v, in forward direction   b) 3 v in forward direction

c) v, in backward direction   d) 3 v in backward direction

109. Four particles given, have same momentum. Which has maximum kinetic energy

a) Proton   b) Electron   c) Deutron   d) α- particles

110. If reaction is R and coefficient of friction is μ, what is work done against friction in moving a body by distance d?
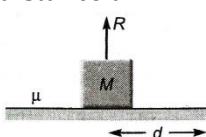
a) $\dfrac{\mu Rd}{4}$ b) $2\mu Rd$ c) μRd d) $\dfrac{\mu Rd}{2}$

111. The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant k and compresses it by length L. The maximum momentum of the block after collides is
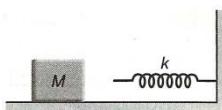
a) $\sqrt{MkL}$ b) $\dfrac{kL^2}{2M}$ c) Zero   d) $\dfrac{ML^2}{k}$

112. In which case does the potential energy decrease

a) On compressing a spring   b) On stretching a spring

c) On moving a body against gravitational force   d) On the rising of an air bubble in water

113. Two bodies A and B have masses 2 kg and 5 kg respectively. Each one is acted upon by a force of 4 kg wt. If they acquire the same kinetic energy in times t_A and t_B, then the ratio $\dfrac{t_A}{t_B}$ is

a) $\dfrac{1}{2}$ b) 2   c) $\dfrac{2}{5}$ d) $\dfrac{5}{6}$

114. If a lighter body (Mass M_1 and velocity V_1) and a heavier body (mass M_2 and velocity V_2) have the same

kinetic energy, then

a) $M_2V_2 < M_1V_1$ b) $M_2V_2 = M_1V_1$ c) $M_2V_1 = M_1V_2$ d) $M_2V_2 > M_1V_1$

115. A body moves a distance of 10 m along a straight line under action of 5 N force. If work done is 25 J, then angle between the force and direction of motion of the body will be

a) 75^0 b) 60^0 c) 45^0 d) 30^0

116. A body of mass 5 kg moving with a velocity 10 m/s collides with another body of the mass 20 kg at, rest and comes to rest. The velocity of the second body due to collision is

a) 2.5 m/s b) 5 m/s c) 7.5 m/s d) 10 m/s

117. An object of mass m is tied to a string of length L and a variable horizontal force is applied on it which starts at zero and gradually increases until the string makes an angel θ with the vertical. Work done by the force F is
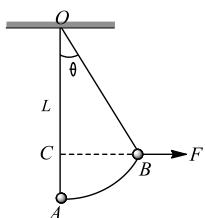
a) $mgL(1 - \sin\theta)$ b) mgL c) $mgL(1 - \cos\theta)$ d) $mgL(1 + \cos\theta)$

118. A spring with spring constant k is extended from $x = 0$ to $x = x_1$. The work done will be

a) kx_1^2 b) $\dfrac{1}{2}kx_1^2$ c) $2kx_1^2$ d) $2kx_1$

119. A ball of mass m falls vertically to the ground from a height h_1 and rebound to a height h_2. The change in momentum of the ball on striking the ground is

a) $mg(h_1 - h_2)$

b) $mg(\sqrt{2gh_1} + \sqrt{2gh_2})$

c) $m\sqrt{2g(h_1 + h_2)}$

d) $m\sqrt{2g}(h_1 + h_2)$

120. A body of mass M_1 collides elastically with another mass M_2 at rest. There is maximum transfer of energy when

a) $M_1 > M_2$

b) $M_1 < M_2$

c) $M_1 = M_2$

d) Same for all values of M_1 and M_2

121. A mass of 10 g moving with a velocity of 100 cm/s strikes a pendulum bob of mass 10 g. The two masses stick together. The maximum height reached by the system now is ($g = 10 \ m/s^2$)

a) Zero   b) 5 cm c) 2.5 cm d) 1.25 cm

122. It is easier to draw up a wooden block along an inclined plane than to haul it vertically, principally because

a) The friction is reduced

b) The mass becomes smaller

c) Only a part of the weight has to be overcome

d) 'g' becomes smaller

123. A particle acted upon by constant forces $4\hat{i} + \hat{j} - 3\hat{j}$ and $3\hat{i} + \hat{j} - \hat{k}$ is displaced from the point $\hat{i} + 2\hat{j} + 3\hat{k}$ to the point $5\hat{i} + 4\hat{j} + \hat{k}$. The total work done by the forces in SI unit is

a) 20   b) 40   c) 50   d) 30

124. The power of a water pump is 200 kW. If g = 10ms^{-2}, then the amount of water it can raise in 1 min to a height of 10 m is

a) 2000 L   b) 1000 L   c) 100 L   d) 1200 L

125. A sphere of mass m moving with a constant velocity u hits another stationary sphere of the same mass. If e is the coefficient of restitution, then the ratio of the velocity of two spheres after collision will be

a) $\dfrac{1-e}{1+e}$ b) $\dfrac{1+e}{1-e}$ c) $\dfrac{e+1}{e-1}$ d) $\dfrac{e-1}{e+1}t^2$

126. A bullet of mas m moving with velocity v strikes a block of mass M at rest and gets embedded into it. The kinetic energy of the composite block will be

a) $\dfrac{1}{2}mv^2 \times \dfrac{m}{(m+M)}$ b) $\dfrac{1}{2}mv^2 \times \dfrac{M}{(m+M)}$ c) $\dfrac{1}{2}mv^2 \times \dfrac{(M+m)}{(M)}$ d) $\dfrac{1}{2}Mv^2 \times \dfrac{m}{(m+M)}$

127. An α-particle of mass m suffers one dimensional elastic collision with a nucleus of unknown mass. After the

collision the α-particle is scattered directly backward losing 75% of its kinetic energy .then the mass of the nucleus is

a) m
b) 2 m
c) 3 m
d) $\dfrac{3}{2}m$

128. A spring gun of spring constant 90 Ncm^{-1} is compressed 12 cm by a ball of mass 16 g. If the trigger is pulled, the velocity of the ball is

a) 50 ms^{-1}
b) 9 ms^{-1}
c) 40 ms^{-1}
d) 90ms^{-1}

129. If momentum is increased by 20%, then kinetic energy increases by

a) 48%
b) 44%
c) 40%
d) 36%

130. A particle falls from a height h upon a fixed horizontal plane and rebounds. If e is the coefficient of restitution, the total distance travelled before rebounding has stopped is

a) $h\left(\dfrac{1+e^2}{1-e^2}\right)$
b) $h\left(\dfrac{1-e^2}{1+e^2}\right)$
c) $\dfrac{h}{2}\left(\dfrac{1-e^2}{1+e^2}\right)$
d) $\dfrac{h}{2}\left(\dfrac{1+e^2}{1-e^2}\right)$

131. **Statement I**Twoparticles moving in the same direction do not lose all their energy in a completely inelasticcollision.
Statement II Principle of conservationof momentum holds true for all kinds of collisions.

a) Statement I is true, statement II is true, statement II is the correct explanation of statement I.
b) Statement I is true Statement II is true, Statement II is not correct explanation of statement I.
c) Statement I is false, Statement II is true.
d) Statement I is true, Statement II is false.

132. A ball is dropped from a height h. If the coefficient of restitution be e, then to what height will it rise after jumping twice from the ground

a) $eh/2$
b) $2eh$
c) eh
d) e^4h

133. The work done in dragging a stone of mass 100 kg up an inclined plane 1 in 100 through a distance of 10 m is (take g = 9.8 ms^{-2})

a) Zero
b) 980 J
c) 9800 J
d) 98 J

134. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of 0.4 ms^{-1}. It collides head on with the second one elastically, the second one similarly with the third and so on. The velocity of the last ball is

a) 0.4ms^{-1}
b) 0.2ms^{-1}
c) 0.1ms^{-1}
d) 0.05ms^{-1}

135. A car of mass 1000 kg moves at a constant speed of 20 ms^{-1} up an incline. Assume that the frictional force is 200 N and that sin θ = 1/20 where, θ is the angel of the incline to the horizontal. The g = 10 ms^{-2}. Find the power developed by the engine

a) 14 kW
b) 4 kW
c) 10 kW
d) 28 kW

136. Two springs A and B are identical but A is harder than $B(k_A > k_B)$. Let W_A and W_B represent the work done when the springs are stretched through the same distance and W'_A and W'_B are the work done when these are stretched by equal forces, then which of the following is true

a) $W_A > W_B$ and $W'_A = W'_B$
b) $W_A > W_B$ and $W'_A < W'_B$
c) $W_A > W_B$ and $W'_A > W'_B$
d) $W_A < W_B$ and $W'_A < W'_B$

137. A particle of mass 2 kg starts moving in a straight line with an initial velocity of 2 ms^{-1} at a constant acceleration of 2 ms^{-2}. Then rate of change of kinetic energy

a) Is four times the velocity at any moment
b) Is two times the displacement at any moment
c) Is four times the rate of change of velocity at any moment
d) Is constant through out

138. A rubber ball is dropped from a height of 5 m on a planet, where the acceleration due to gravity is not known. On bouncing it rises to 1.8 m. The ball loses its velocity on bouncing by a factor of

a) $\dfrac{16}{25}$
b) $\dfrac{2}{5}$
c) $\dfrac{3}{5}$
d) $\dfrac{9}{25}$

139. If a body of mass 200 g falls from a height 200 m and its total P.E. is converted into K.E. at the point of contact of the body with earth surface, then what is the decrease in P.E. of the body at the contact ($g = 10\ m/s^2$)

a) $200\ J$ b) $400\ J$ c) $600\ J$ d) $900\ J$

140. A machine which is 75 percent efficient, uses 12 joules of energy in lifting up a $1\ kg$ mass through a certain distance. The mass is then allowed to fall through that distance. The velocity at the end of its fall is (in ms^{-1})

a) $\sqrt{24}$ b) $\sqrt{32}$ c) $\sqrt{18}$ d) $\sqrt{9}$

141. Two spherical bodies of the same mass M are moving with velocities v_1 and v_2. These collide perfectly inelastically , then the loss in kinetic energy is

a) $\dfrac{1}{2}M(v_1 - v_2)$ b) $\dfrac{1}{2}M(v_1^2 - v_2^2)$ c) $\dfrac{1}{4}M(v_1 - v_2)^2$ d) $2M(v_1^2 - v_2^2)$

142. A position-dependent force $F = 3x^2 - 2x + 7$ acts on a body of mass 7 kg and displaces it from $x = 0$ m to $x = 5m$. The work done on the body is x' joule. If both F and x are measured in SI units, the value of x' is

a) 135   b) 235   c) 335   d) 935

143. A bullet is fired from a rifle. If the riffle recoils freely, then the kinetic energy of the rifle is

a) Less than that of the bullet   b) More than that of the bullet

c) Same as that of the bullet   d) Equal or less than that of the bullet

144. In an inelastic collision, what is conserved

a) Kinetic energy   b) Momentum   c) Both (a) and (b)   d) Neither (a) nor (b)

145. A 2.0 kg block is dropped from a height of 40 cm onto a spring of spring constant $k = 1960\ \text{Nm}^{-1}$. Find the maximum distance the spring is compressed

a) 0.080 m   b) 0.20 m   c) 0.40 m   d) 0.10 m

146. A ball is dropped from height 20 m. If coefficient of restitution is 0.9, what will be the height attained after first bounce?

a) $1.62\ m$ b) 16.2 m   c) 18 m   d) 14 m

147. A car is moving with a speed of 100 kmh^{-1}. If the mass of the car is 950 kg, then its kinetic energy is

a) $0.367\ M$ J   b) 3.67 J   c) $3.67\ M$ J   d) 367 J

148. A body of mass $2\ kg$ moving with a velocity of $3\ m/sec$ collides head on with a body of mass $1\ kg$ moving in opposite direction with a velocity of $4\ m/sec$. After collision, two bodies stick together and move with a common velocity which in m/sec is equal to

a) 1/4   b) 1/3   c) 2/3   d) 3/4

149. A particle is moving under the influence of a force given by $F = kx$ where k is a constant and x is the distance moved. The energy (in joules) gained by the particle in moving from $x = 0$ to $x = 3$ is

a) $2.5\ k$ b) $3.5\ k$ c) $4.5\ k$ d) $9\ k$

150. If a man speeds up by 1ms^{-1}, his KE increase by 44%. His original speed in ms^{-1} is

a) 1   b) 2   c) 5   d) 4

151. The energy which an e^- acquires when accelerated through a potential difference of 1 volt is called

a) $1\ Joule$ b) $1\ eV$ c) $1\ Erg$ d) $1\ Watt$

152. A ball is projected vertically upwards with a certain initial speed. Another ball of the same mass is projected at an angle of 60° with the vertical with the same initial speed. At highest points of their journey, the ratio of their potential energies will be

a) $1:1$ b) $2:1$ c) $3:2$ d) $4:1$

153. If the $K.E.$ of a body is increased by 300%, its momentum will increase by

a) 100%   b) 150%   c) $\sqrt{300}$%   d) 175%

154. A ball is projected vertically down with an initial velocity from a height of $20\ m$ onto a horizontal floor. During the impact it loses 50% of its energy and rebounds to the same height. The initial velocity of its projection is

a) $20\ ms^{-1}$ b) $15\ ms^{-1}$ c) $10\ ms^{-1}$ d) $5\ ms^{-1}$

155. An engine of power 7500 W makes a train move on a horizontal surface with constant velocity of 20 ms^{-1}. The force involved in the problem is

a) 375 N   b) 400 N   c) 500 N   d) 600 N

156. Identify the wrong statement
    a) A body can have momentum without energy
    b) A body can have energy without momentum
    c) The momentum is conserved in an elastic collision
    d) Kinetic energy is not conserved in an inelastic collision
157. If a shell fired from a cannon, explodes in mid air, then
    a) Its total kinetic energy increases
    b) Its total momentum increases
    c) Its total momentum decreases
    d) None of these
158. A body of mass 2 kg is thrown up vertically with kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of its original value is?
    a) 50 m
    b) 12.25 m
    c) 25 m
    d) 10 m
159. A particle is moving under the influence of a force given by $F = kx$, where k is a constant and x is the distance moved. The energy (in joule)gained by the particle in moving from $x = 0$ to $x = 3$ is
    a) 2 k
    b) 3.5 k
    c) 4.5 k
    d) 9 k
160. The kinetic energy acquired by a mass m in travelling a certain distance d starting from rest under the action of a constant force is directly proportional to
    a) $\sqrt{m}$
    b) Independent of m
    c) $1/\sqrt{m}$
    d) m
161. Statement I In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.
    Statement II Inan elastic collision, the linear momentum of the system is conserved.
    a) Statement I is true ,statement II is true; statement II is a correct explanation for statement I
    b) Statement I is true, Statement II is true; statement II is not correct explanation for statement I
    c) Statement I is true, Statement II is false
    d) Statement I is false, Statement II is True
162. A force acts on a 30 g particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in $metres$ and t is in seconds. The work done during the first 4 seconds is
    a) 5.28 J
    b) 450 mJ
    c) 190 mJ
    d) 530 mJ
163. A ball is released from the top of a tower. The ratio of work done by force of gravity in first, second and third second of the motion of the ball is
    a) $1: 2: 3$
    b) $1: 4: 9$
    c) $1: 3: 5$
    d) $1: 5: 3$
164. A spring with spring constant k is extended from $x = 0$ to $x = x_1$.The work done will be
    a) κx_1^2
    b) $\frac{1}{2}\kappa x_1^2$
    c) $2\kappa x_1^2$
    d) $2\kappa x_1$
165. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision their final velocities are V and v respectively. The value of v is
    a) $\dfrac{2uM}{m}$
    b) $\dfrac{2um}{M}$
    c) $\dfrac{2u}{1 + \frac{m}{M}}$
    d) $\dfrac{2u}{1 + \frac{M}{m}}$
166. If a force F is applied on a body and it moves with a velocity v, the power will be
    a) $F \times v$
    b) F/v
    c) F/v^2
    d) $F \times v^2$
167. The work done in pulling up a block of wood weighing 2 kN for a length of 10 m on a smooth plane inclined at an angle of 15° with the horizontal is [sin 15° = 0.2588]
    a) 4.36 kJ
    b) 5.17 kJ
    c) 8.91 kJ
    d) 9.82 kJ
168. A wire is stretched under a force. If the wire suddenly snaps the temperature of the wire
    a) Remains the same
    b) Decreases
    c) Increases
    d) First decreases then increases
169. A mass of 100 g strikes the wall with speed 5 m/s at an angle as shown in figure and it rebounds with the same speed. If the contact time is 2×10^{-3}sec, what is the force applied on the mass by the wall
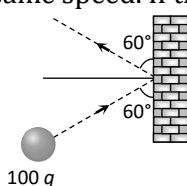
a) $250\sqrt{3}\ N$ to right   b) $250\ N$ to right   c) $250\sqrt{3}\ N$ to left   d) $250\ N$ to left

170. A bullet of mass 0.02 kg travelling horizontally with velocity 250 ms^{-1} strikes a block of wood of mass 0.23 kg which rests on a rough horizontal surface. After the impact, the block and bullet move together and come to rest after travelling a distance of $40m$. The coefficient of sliding friction of the rough surface is ($g = 9.8\ ms^{-2}$)

a) 0.75   b) 0.61   c) 0.51   d) 0.30

171. An engine develops 10 kW of power. How much time will it take to lift a mass of 200 $kg$to a height of 40 m ($g = 10\ m/sec^2$)

a) 4 sec b) 5 sec c) 8 sec d) 10 sec

172. A neutron having mass of $1.67 \times 10^{-27}\ kg$ and moving at $10^8 m/s$ collides with a deutron at rest and sticks to it. If the mass of the deutron is $3.34 \times 10^{-27}\ kg$ then the speed of the combination is

a) $2.56 \times 10^3\ m/s$ b) $2.98 \times 10^5\ m/s$ c) $3.33 \times 10^7\ m/s$ d) $5.01 \times 10^9\ m/s$

173. A ball of mass $2kg$ and another of mass $4kg$ are dropped together from a 60 $feet$ tall building. After a tall of 30 $feet$ each towards earth, their respective kinetic energies will be in the ratio of

a) $\sqrt{2} : 1$ b) $1 : 4$ c) $1 : 2$ d) $1 : \sqrt{2}$

174. 10 L of water per second is lifted from well through 20 m and delivered with a velocity of $10ms^{-1}$,then the power of the motor is

a) 1.5 Kw   b) 2.5 Kw   c) 3.5 Kw   d) 4.5 Kw

175. A bucket tied to a string is lowered at a constant acceleration of $\frac{g}{4}$. If the mass of the bucket is m and is lowered by a distance d, the work done by the string will be

a) $\dfrac{mgd}{4}$ b) $-\dfrac{3}{4}mgd$ c) $-\dfrac{4}{3}mgd$ d) $\dfrac{4}{3}mgd$

176. A 20 kg ball moving with a velocity 6 ms^{-1} collides with a 30 kg ball initially at rest .if both of them coalesce ,then final velocity of the combined mass is

a) $6\ ms^{-1}$ b) $5\ ms^{-1}$ c) $3.6\ ms^{-1}$ d) $2.4ms^{-1}$

177. A body of mass 3 kg acted upon by a constant force is displaced by Smetre, given by relation$S = \frac{1}{3}t^2$, where t is in second. Work done by the force in 2 seconds is

a) $\dfrac{8}{3}$ J   b) $\dfrac{19}{5}$J   c) $\dfrac{5}{19}$J   d) $\dfrac{3}{8}$ J

178. The blocks of mass m each are connected to a spring of spring constant k as shown in figure. The maximum displacement in the block is

a) $\sqrt{\dfrac{2mv^2}{k}}$ b) $\sqrt{\dfrac{mv^2}{k}}$ c) $2\sqrt{\dfrac{mv^2}{k}}$ d) $2\sqrt{\dfrac{k}{mv^2}}$

179. In an elastic collision of two particles the following is conserved

a) Momentum of each particle   b) Speed of each particle
c) Kinetic energy of each particle   d) Total kinetic energy of both the particles

180. A rod AB of mass 10 kg and length 4 m rests on a horizontal floor with end A fixed so as to rotate it in vertical plane about perpendicular axis passing through A. If the work done on the rod is 100 J, the height to which the end B be raised vertically above the floor is

a) 1.5 m   b) 2.0 m   c) 1.0 m   d) 2.5 m

181. A body moves from a position r_1= (2$\hat{i}$-3$\hat{j}$-4$\hat{k}$) m to a position, r2= (3$\hat{i}$-43$\hat{j}$-5$\hat{k}$) m under the influence of a constant force F= $(4\hat{i} - 4\hat{j} + 5\hat{k})$ N. The work done by the force is

a) 57 J   b) 58 J   c) 59 J   d) 60 J

182. The relationship between force and position is shown in the figure given (in one dimensional case). The work done by the force in displacing a body from $x = 1\ cm$ to $x = 5\ cm$ is
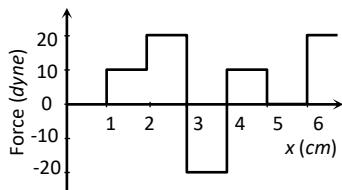
a) $20\ ergs$ b) $60\ ergs$ c) $70\ ergs$ d) $700\ ergs$

183. Choose the incorrect statement

a) No work is done if the displacement is perpendicular to the direction of the applied force

b) If the angle between the force and displacement vectors is obtuse, then the work done is negative

c) Frictional force in non-conservative

d) All the central forces are non-conservative

184. An elastic string of unstretched length L and force constant k is stretched by a small length x. It is further stretched by another small length y. The work done in the second stretching is

a) $\frac{1}{2}ky^2$ b) $\frac{1}{2}k(x^2 + y^2)$ c) $\frac{1}{2}k(x + y)^2$ d) $\frac{1}{2}ky(2x + y)$

185. A ball is dropped from a height h on a floor of coefficient of restitution e. The total distance covered by the ball just before second hit is

a) $h(1 - 2e^2)$ b) $h(1 + 2e^2)$ c) $h(1 + e^2)$ d) he^2

186. A stationary bomb explodes into two parts of masses in the ratio of 1:3 .If the heavier mass moves with a velocity $4ms^{-1}$, what is the velocity of lighter part?

a) 12ms^{-1} opposite to heavier mass   b) 12ms^{-1} in the direction of heavier mass

c) 6ms^{-1} opposite to heavier mass   d) 6ms^{-1} in the direction heavier mass

187. A spring of spring constant $5 \times 10^3\ N/m$ is stretched initially by $5\ cm$ from the unstretched position. Then the work required to stretch it further by another $5cm$ is

a) $6.25\ N\text{-}m$ b) $12.50\ N\text{-}m$ c) $18.75\ N\text{-}m$ d) $25.00\ N\text{-}m$

188. Two bodies having same mass $40\ kg$ are moving in opposite directions, one with a velocity of $10\ m/s$ and the other with $7\ m/s$. If they collide and move as one body, the velocity of the combination is

a) $10\ m/s$ b) $7\ m/s$ c) $3\ m/s$ d) $1.5\ m/s$

189. Two masses of $0.25\ kg$ each moves towards each other with speed $3ms^{-1}$ and $1ms^{-1}$ collide and stick together. Find the final velocity

a) $0.5\ ms^{-1}$ b) $2ms^{-1}$ c) $1ms^{-1}$ d) $0.25\ ms^{-1}$

190. A bullet fired from a gun with a velocity of $10^4\ \text{ms}^{-1}$ goes through a bag full of straw. If the bullet loses half of its kinetic energy in the bag, its velocity when it comes out of the bag will be

a) $7071.06\ \text{ms}^{-1}$ b) $707\ \text{ms}^{-1}$ c) $70.71\ \text{ms}^{-1}$ d) $707.06\ \text{ms}^{-1}$

191. A bomb of mass 9 kg explodes into two parts. One part of mass 3 kg moves with velocity 16 m/s ,then the KE of the other part is

a) 162 J   b) 150 J   c) 192 J   d) 200 J

192. A body of mass 'M' collides against a wall with a velocity v and retraces its path with the same speed. The change in momentum is (take initial direction of velocity as positive)

a) Zero   b) $2Mv$ c) Mv d) $-2\ Mv$

193. The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from $x = 1m$ to $x = 5$m will be
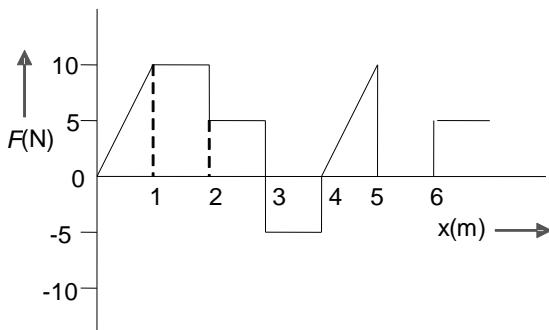
a) 30 J   b) 15 J   c) 25 J   d) 20 J

194. A block C of mass m is moving with velocity v_0 and collides elastically with block A of mass m and connected to another block B of mass $2m$ through spring constant k. What is k if x_0 is compression of spring when velocity of A and B is same ?


a) $\dfrac{mv_0^2}{X_0^2}$ b) $\dfrac{mv_0^2}{2x_0^2}$ c) $\dfrac{3}{2}\dfrac{mv_0^2}{x_0^2}$ d) $\dfrac{2}{3}\dfrac{mv_0^2}{x_0^2}$

195. A canon ball is fired with a velocity 200 m/sec at an angle of 60° with the horizontal. At the highest point of its flight it explodes into 3 equal fragments, one going vertically upwards with a velocity 100 m/sec, the second one falling vertically downwards with a velocity 100 m/sec. The third fragment will be moving with a velocity
a) 100 m/s in the horizontal direction
b) 300 m/s in the horizontal direction
c) 300 m/s in a direction making an angle of 60° with the horizontal
d) 200 m/s in a direction making an angle of 60° with the horizontal

196. If $w_1, w_2 \text{ and } w_3$ represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively (as shown) in the gravitational field of a point mass m. Find the correct relation between $w_1, w_2 \text{ and } w_3$
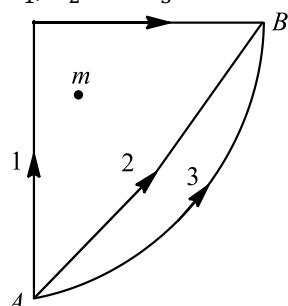
a) $w_1 > w_2 > w_3$ b) $w_1 = w_2 = w_3$ c) $w_1 < w_2 < w_3$ d) $w_2 > w_1 > w_3$

197. A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, travelling with a velocity V m/s in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity V of the bullet is
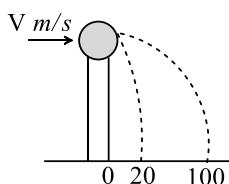
a) 250 m/s b) $250\sqrt{2}$ m/s c) 400 m/s d) 500 m/s

198. A gun of mass 20 kg has bullet of mass 0.1 kg in it. The gun is free to recoil 804 J of recoil energy are released on firing the gun. The speed of bullet (ms^{-1}) is

a) $\sqrt{804 \times 2010}$ b) $\sqrt{\dfrac{2010}{804}}$ c) $\sqrt{\dfrac{804}{2010}}$ d) $\sqrt{804 \times 4 \times 10^3}$

199. A particle is placed at the origin and a force $F = kx$ is acting on it (where k is positive constant). If $U(0) = 0$, the graph of $U(x)$ versus x will be (where U is the potential energy function)

a)   b)   c)   d)
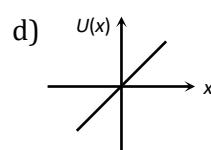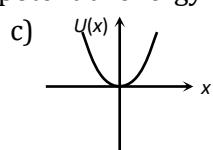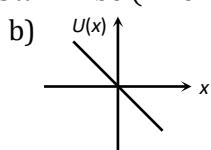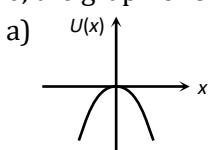
200. A wire of length L suspended vertically from a rigid support is made to suffer extension l in its length by applying a force F. The work is

a) $\dfrac{Fl}{2}$ b) Fl c) $2Fl$ d) Fl

201. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of $0.4 \ m/s$. It collides head on with the second elastically, the second one similarly with the third and so on. The velocity of the last ball is

a) $0.4 \ m/s$ b) $0.2 \ m/s$ c) $0.1 m/s$ d) $0.05 \ m/s$

202. The coefficient of restitution e for a perfectly inelastic collision is

a) 1   b) 0   c) ∞ d) -1

203. A 50 g bullet moving with velocity 10 m/s strikes a block of mass 950 g at rest and gets embedded in it. The loss in kinetic energy will be

a) 100%   b) 95%   c) 5%   d) 50%

204. A body falls on a surface of coefficient of restitution 0.6 from a height of 1 m. Then the body rebounds to a height of

a) $0.6 \ m$ b) $0.4 \ m$ c) $1 \ m$ d) $0.36 \ m$

205. A man pushes a wall and falls to displace it. He does

a) Negative work   b) Positive but not maximum work

c) No work at all   d) Maximum work

206. Three identical spherical balls A, B and C are placed on a table as shown in the figure along a straight line. B and C are at rest initially
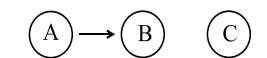
The ball A and B head on with a speed of $10 ms^{-1}$. Then after all collisions (assumed to be elastic) A and B are brought to rest and C takes off with a velocity of

a) $5 \ m \ s^{-1}$ b) $10 \ m \ s^{-1}$ c) $2.5 \ m \ s^{-1}$ d) $7.5 \ m \ s^{-1}$

207. A spring with spring constant k when stretched through 1 cm the potential energy is U.If it is stretched by 4 cm ,the potential energy will be

a) 4U   b) 8U   c) 16U   d) 2U

208. The potential energy of a system is represented in the first figure. The force acting on the system will be represented by

a)   b)   c)   d)
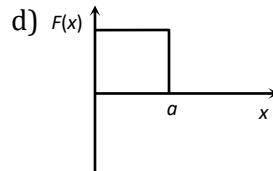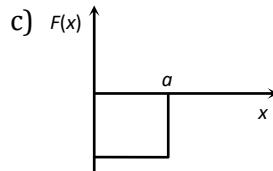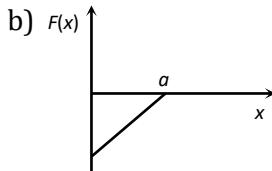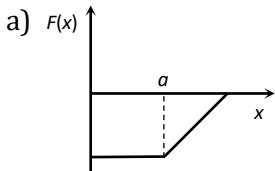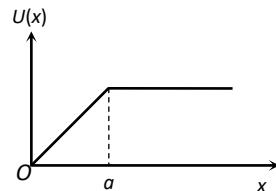
209. A particle is released from a height h, At a certain height; its KE is two times its potential energy. Height and speed of the particle at that instant are

a) $\dfrac{h}{3}, \sqrt{\dfrac{2gh}{3}}$ b) $\dfrac{h}{3}, 2\sqrt{\dfrac{gh}{3}}$ c) $\dfrac{2h}{3}, \sqrt{\dfrac{2gh}{3}}$ d) $\dfrac{h}{3}, \sqrt{2gh}$

210. Power applied to particle varies with time as $p = (3 \ t^2 - 2t + 1)W$,where t is in second. Find the change in its kinetic energy between t=1s and t=4s

a) 32 J   b) 46 J   c) 61 J   d) 102 J

211. A constant power p is applied to a car starting from rest. If v is the velocity of the car at time t, then

a) $v \propto t$ b) $v \propto \dfrac{1}{t}$ c) $v \propto \sqrt{t}$ d) $v \propto \dfrac{1}{\sqrt{t}}$

212. A space craft of mass 'M' and moving with velocity 'v' suddenly breaks in two pieces of same mass m. After the explosion one of the mass 'm' becomes stationary. What is the velocity of the other part of craft

a) $\dfrac{Mv}{M-m}$ b) v c) $\dfrac{Mv}{m}$ d) $\dfrac{M-m}{m}v$

213. A body of mass 2 kg is moving with velocity 10 m/s towards east. Another body of same mass and same velocity moving towards north collides with former and coalesces and moves towards north-east. Its velocity is

a) 10 m/s b) 5 m/s c) 2.5 m/s d) $5\sqrt{2}\ m/s$

214. A ball moves in a frictionless inclined table without slipping. The work done by the table surface on the ball is

a) Positive   b) Negative   c) Zero   d) None of these

215. In a head on elastic collision of a very heavy body moving at v with a light body at rest, velocity of heavy body after collision is

a) v b) $2v$ c) Zero   d) $\dfrac{v}{2}$

216. A mass M is lowered with the help of a string by a distance h at a constant acceleration g/2. The work done by the string will be

a) $\dfrac{Mgh}{2}$ b) $\dfrac{-Mgh}{2}$ c) $\dfrac{3Mgh}{2}$ d) $\dfrac{-3Mgh}{2}$

217. A frictionless track $ABCDE$ ends in a circular loop of radius R. A body slides down the track from point A which is it a height $h = 5\ cm$. Maximum value of R for the body to successfully complete the loop is
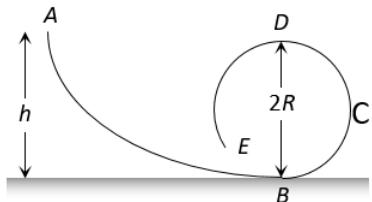
a) 5 cm b) $\dfrac{15}{4}\ cm$ c) $\dfrac{10}{3}\ cm$ d) 2 cm

218. A particle is dropped from a height h. A constant horizontal velocity is given to the particle. Taking g to be constant every where, kinetic energy E of the particle $w.r.t.$ time t is correctly shown in

a)   b)   c)   d)
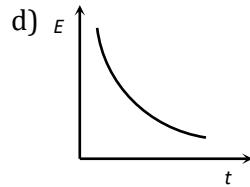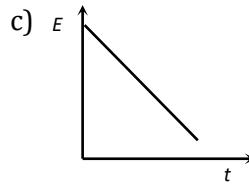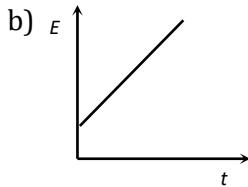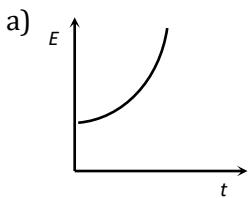
219. Two bodies of masses m_1 and m_2 have equal kinetic energies. If p_1 and p_2 are their respective momentum, then ratio $p_1 : p_2$ is equal to

a) $m_1 : m_2$ b) $m_2 : m_1$ c) $\sqrt{m_1} : \sqrt{m_2}$ d) $m_1^2 : m_2^2$

220. A metal ball of mass 2 kg moving with a velocity of 36 km/h has an head on collision with a stationary ball of mass 3 kg. If after the collision, the two balls move together, the loss in kinetic energy due to collision is

a) 40 J b) 60 J c) 100 J d) 140 J

221. A particle of mass m moving with velocity V_0 strikes a simple pendulum of mass m and strikes to it. The maximum height attained by the pendulum will be

a) $h = \dfrac{v_0^2}{8g}$ b) $\sqrt{V_0 g}$ c) $2\sqrt{\dfrac{V_0}{g}}$ d) $\dfrac{V_0^2}{4g}$

222. Power supplied to a particle of mass 2 kg varies with time as $P = t^2/2$ watt, where t is in second. If velocity of particle at $t = 0$ is $v = 0$, the velocity of particle at $t = 2s$ will be

a) $1\ \mathrm{ms}^{-1}$ b) $4\ \mathrm{ms}^{-1}$ c) $2\ \mathrm{ms}^{-1}$ d) $2\sqrt{2}\ \mathrm{ms}^{-1}$

223. The slope of the kinetic energy displacement curve of a particle in motion is

a) Equal to the acceleration of the particle   b) Inversely proportional to the acceleration

c) Directly proportional to the acceleration   d) None of the above

224. Velocity-time graph of a particle of mass 2 kg moving in a straight line is as shown in figure. Work done by all forces on the particle is
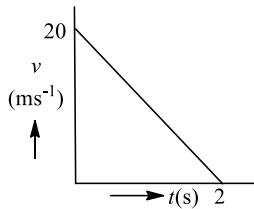
a) 400 J   b) −400 J   c) −200 J   d) 200 J

225. A quarter horse power motor runs at a speed of $600\ r.p.m.$ Assuming 40% efficiency the work done by the motor in one rotation will be

a) $7.46\ J$ b) $7400\ J$ c) $7.46\ ergs$ d) $74.6\ J$

226. From an automatic gun a man fires 360 bullet per minute with a speed of $360\ km/hour$. If each weighs $20\ g$, the power of the gun is

a) $600\ W$ b) $300\ W$ c) $150\ W$ d) $75\ W$

227. Two bodies of masses $2m$ and m have their K.E. in the ratio 8: 1, then their ratio of momenta is

a) $1:1$ b) $2:1$ c) $4:1$ d) $8:1$

228. A particle is released from a height S. At certain height its kinetic energy is three times its potential energy. The height and speed of the particle at that instant are respectively

a) $\dfrac{S}{4}, \dfrac{3gS}{2}$ b) $\dfrac{S}{4}, \dfrac{\sqrt{3gS}}{2}$ c) $\dfrac{S}{2}, \dfrac{\sqrt{3gS}}{2}$ d) $\dfrac{S}{4}. \dfrac{\sqrt{3gS}}{2}$

229. If velocity of a body is twice of previous velocity, then kinetic energy will become

a) 2 times   b) $\dfrac{1}{2}$ times   c) 4 times   d) 1 times

230. A cord is used to lower vertically a block of mass M by a distance d with constant downward acceleration $\dfrac{g}{4}$. Work done by the cord on the block is

a) $Mg\dfrac{d}{4}$ b) $3Mg\dfrac{d}{4}$ c) $-3\ Mg\dfrac{d}{4}$ d) Mgd

231. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to

a) $t^{1/2}$ b) t c) $t^{3/2}$ d) t^2

232. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to

a) $t^{1/2}$ b) t c) $t^{3/2}$ d) t^2

233. Given below is a graph between a variable force (F) (along y-axis) and the displacement (X) (along x-axis) of a particle in one dimension. The work done by the force in the displacement interval between $0\ m$ and $30\ m$ is
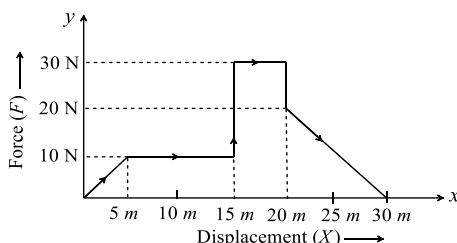
a) $275\ J$ b) $375\ J$ c) $400\ J$ d) $300\ J$

234. An electric pump is used to fill an overhead talk of capacity $9m^3$ kept at a height of $10m$ above the ground. If the pump takes 5 minutes to fill the tank by consuming $10kW$ power the efficiency of the pump should be (Take $g = 10ms^{-2}$)

a) 60%   b) 40%   c) 20%   d) 30%

235. The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant K and compresses it by length L. The maximum momentum of the block after collision is
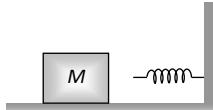
a) Zero

b) $\dfrac{ML^2}{K}$

c) $\sqrt{MK}\, L$

d) $\dfrac{KL^2}{2M}$

236. For inelastic collision between two spherical rigid bodies
   a) The total kinetic energy is conserved
   b) The total mechanical energy is not conserved
   c) The liner momentum is not conserved
   d) The liner momentum is conserved

237. A mass 'm' moves with a velocity 'v' and collides inelastically with another identical mass. After collision the Ist mass moves with velocity $\dfrac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision
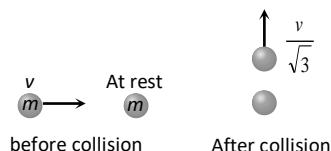
   a) $\dfrac{2}{\sqrt{3}}v$

   b) $\dfrac{v}{\sqrt{3}}$

   c) v

   d) $\sqrt{3}\,v$

238. A cylinder of mass $10kg$ is sliding on a plane with an initial velocity of $10\ m/s$. If coefficient of friction between surface and cylinder is 0.5, then before stopping it will describe
   a) $12.5\ m$
   b) $5\ m$
   c) $7.5\ m$
   d) $10\ m$

239. A stone is dropped from the top of a tall tower. The ratio of the kinetic energy of the stone at the end of three seconds to the increase in the kinetic energy of the stone during the next three seconds is
   a) $1:1$
   b) $1:2$
   c) $1:3$
   d) $1:9$

240. A body of mass m is at rest. Another body of same mass moving with velocity V makes head on elastic collision with the first body. After collision the first body starts to move with velocity
   a) V
   b) $2V$
   c) Remain at rest
   d) No predictable

241. The bob of a simple pendulum (mass m and length l) dropped from a horizontal position strikes a block of the same mass elastically placed on a horizontal frictionless table. The K.E. of the block will be
   a) $2\ mgl$
   b) $mgl/2$
   c) mgl
   d) 0

242. 1 kg body explodes into three fragments. The ratio of their masses is 1:1:3. The fragments of same mass move perpendicular to each other with speeds 30ms^{-1}, while the heavier part remains in the initial direction. The speed of heavier part is
   a) $\dfrac{10}{\sqrt{2}}\text{ms}^{-1}$
   b) $10\sqrt{2}\text{ms}^{-1}$
   c) $20\sqrt{2}\text{ms}^{-1}$
   d) $30\sqrt{2}\text{ms}^{-1}$

243. A bullet hits and gets embedded in a solid block resting on a frictionless surface .In this process which one of the following is correct?
   a) Only momentum is conserved
   b) Only kinetic energy is conserved
   c) Neither momentum nor kinetic energy is conserved
   d) Both momentum and kinetic energy are conserved

244. The height of the dam, in a hydroelectric power station is 10m. In order to generate 1 MW of electric power, the mass of water (in kg/s) that must fall per second on the blades of the turbines
   a) 10^6
   b) 10^5
   c) 10^3
   d) 10^4

245. A body of mass 3 kg is under a force which causes a displacement in it, given by $s = t^2/3$ (in m). Find the work done by the force in 2 s
   a) 2 J
   b) 3.8 J
   c) 5.2 J
   d) 2.6 J

246. A running man has the same kinetic energy as that of a boy of half his mass. The man speed up by 2 ms^{-1} and the boy changes his speed by $x = \text{ms}^{-1}$, so that the kinetic energies of the boy and the man are again equal. Then x in ms^{-1} is
   a) $-2\sqrt{2}$
   b) $+2\sqrt{2}$
   c) $\sqrt{2}$
   d) 2

247. In an inelastic collision
   a) Only momentum is conserved
   b) Only kinetic energy is conserved
   c) Neither momentum nor kinetic energy is conserved
   d) Both momentum and kinetic energy are conserved

248. An object of mass m is attached to light string which passes through a hollow tube. The object is set into rotation in a horizontal circle of radius , r_1. If the string is pulled shortening the radius to r_2, the ratio of new kinetic energy to the original kinetic energy is
   a) $\left(\dfrac{r_2}{r_1}\right)^2$
   b) $\left(\dfrac{r_1}{r_2}\right)^2$
   c) $\dfrac{r_1}{r_2}$
   d) $\dfrac{r_2}{r_1}$

249. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking $g = 10\ m/s^2$, find the work done (in joules) by the string on the block of mass 0.36 kg during the first second after the system is released from rest
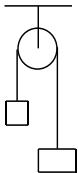
   a) 6 $Joule$
   b) 5 $Joule$
   c) 8 $Joule$
   d) 2 $Joule$

250. An object of mass $3m$ splits into three equal fragments. Two fragments have velocities $v\hat{j}$ and $v\hat{i}$. The velocity of the third fragment is
   a) $v(\hat{j} - \hat{i})$
   b) $v(\hat{i} - \hat{j})$
   c) $-v(\hat{i} + \hat{j})$
   d) $\dfrac{v(\hat{i} + \hat{j})}{\sqrt{2}}$

251. A ball dropped from a height of 2 m rebounds to a height of 1.5 m after hitting the ground. Then the percentage of energy lost is
   a) 25
   b) 30
   c) 50
   d) 100

252. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller mass goes at a speed of 80 m/s. The total energy imparted to the two fragments is
   a) 1.07 kJ
   b) 2.14 kJ
   c) 2.4 kJ
   d) 4.8 kJ

253. In a children's park, there is a slide which has a total length of 10 m and a height of 8.0 m. A vertical ladder is provided to reach the top. A boy weighing 200 N climbs up the ladder to the top of the slide and slides down to the ground. The average friction offered by the slide is three-tenth of his weight. The work done by the slide on the boy as he comes down is
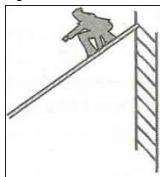
   a) Zero
   b) +600 J
   c) −600 J
   d) +1600 J

254. An athlete in the Olympic covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range
   a) 200 J-500 J
   b) $2 \times 10^5 J - 3 \times 10^5$ J
   c) 20000 J−50000 J
   d) 2000 J − 5000 J

255. A uniform chain of length L and mass M overhangs a horizontal table with its two-third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is
   a) $-\dfrac{1}{4}\mu MgL$
   b) $-\dfrac{2}{9}\mu MgL$
   c) $-\dfrac{4}{9}\mu MgL$
   d) $-\dfrac{6}{7}\mu MgL$

256. A force F acting on an object varies with distance x as shown here. The force is in $newton$ and x in $metre$. The work done by the force in moving the object from $x = 0$ to $x = 6m$ is
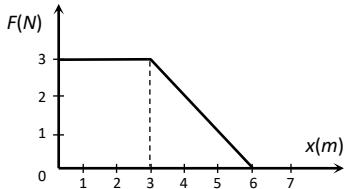
a) $4.5\ J$ b) $13.5\ J$ c) $9.0\ J$ d) $18.0\ J$

257. A body of mass m moving with a constant velocity v hits another body of the same mass moving with the same velocity v but in the opposite direction and sticks to it. The velocity of the compound body after collision is

a) v b) $2v$ c) Zero   d) $v/2$

258. An engine pumps water continuously through a hole. Speed with which water passes through the hole nozzle is v and k is the mass per unit length of the water jet as it leaves the nozzle. Find the rate at which kinetic energy is being imparted to the water

a) $\dfrac{1}{2}kv^2$ b) $\dfrac{1}{2}kv^3$ c) $\dfrac{v^2}{2k}$ d) $\dfrac{v^3}{2k}$

259. A stone of mass 2 kg is projected upward with KE of 98 J. The height at which the KE of the body becomes half its original value, is given by (Take $g = 10\text{ms}^{-2}$)

a) 5 m   b) 2.5 m   c) 1.5 m   d) 0.5 m

260. Consider a rubber ball freely falling from a height $h = 4.9\ m$ onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic.
Then the velocity as a function of time and the height as a function of time will be
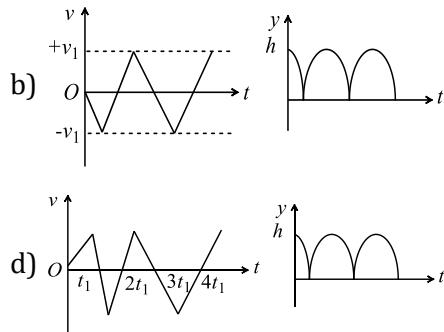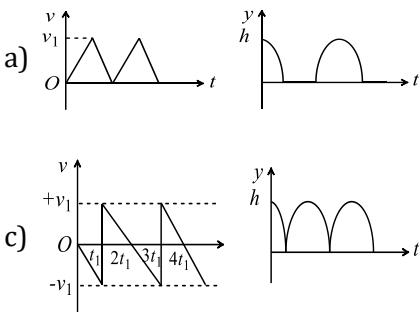
261. In an explosion a body breaks up into two pieces of unequal masses.In this
a) Both parts will have numerically equal momentum
b) Lighter part will have more momentum
c) Heavier part will have more momentum
d) Both parts will have equal kinetic energy

262. A lorry and a car moving with the same K.E. are brought to rest by applying the same retarding force, then
a) Lorry will come to rest in a shorter distance
b) Car will come to rest in a shorter distance
c) Both come to rest in a same distance
d) None of the above

263. A body constrained to move in the y-direction is subjected to force $\mathbf{F} = 2\hat{\imath} + 15\hat{\jmath} + 6\hat{k}$N. The work done by this force in moving the body through a distance of 10 m along y-axis is
a) 100 J   b) 150 J   c) 120 J   d) 200 J

264. For a system to follow the law of conservation of linear momentum during a collision , the condition is
Total external force acting on the system is zero.
Total external force acting on the system finite and time of collision is negligible.
Total internal force acting on the system is zero.
a) (1)only   b) (2)only   c) (3)only   d) (1)and (2)

265. If a particle is compelled to move on a given smooth plane curve under the action of given forces in the plane $\vec{F} = x\hat{\imath} + y\hat{\jmath}$, then

a) $\vec{F}.\overrightarrow{dr} = xdx + ydy$ b) $\displaystyle\int \vec{F}.\overrightarrow{dr} \neq \frac{1}{2}mv^2$

c) $\vec{F}.\overrightarrow{dr} \neq xdx + ydy$ d) $\dfrac{1}{2}mv^2 \neq \displaystyle\int (xdx + ydy)$

266. A horizontal force of $5N$ is required to maintain a velocity of $2\ m/s$ for a block of $10\ kg$ mass sliding over a rough surface. The work done by this force in one minute is
a) 600 J b) 60 J c) 6 J d) 6000 J

267. A body of mass M moves with velocity v and collides elastically with another body of mass m $(M >> m)$ at rest , then the velocity of body of mass m is
a) v   b) 2v   c) v/2   d) zero

268. The work done by a force acting on a body is as shown in the graph. The total work done in covering an initial distance of $20\ m$ is

(graph: F(in N) vs S(in m); F axis marked 5, 10, 15, 20; S axis marked 5, 10, 15, 20, 25, 30)
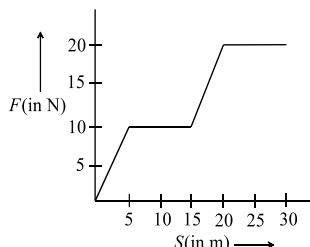
a) 225 J b) 200 J c) 400 J d) 175 J

269. Consider the following statements A and B and identify the correct answer
III. In an elastic collision, if a body suffers a head on collision with another of same mass at rest, the first body comes to rest while the other starts moving with the velocity of the first one
IV. Two bodies of equal mass suffering a head on elastic collision merely exchange their velocities.
a) Both A and B are true   b) Both A and B are false
c) A is true and B is false   d) A is false but B is true

270. A pump motor is used to deliver water at a certain rate from s given pipe. To obtain twice as much water from the same pipe in the same time, power of the motor has to be increased to
a) 16 times   b) 4 times   c) 8 times   d) 2 times

271. A truck of mass 30,000 kg moves up an inclined plane of slope 1 in 100 at a speed of 30 $kmph$. The power of the truck is (Given $g = 10\ ms^{-2}$)
a) 25 kW b) 10 kW c) 5 kW d) 2.5 kW

272. A force of 5 N moves the particle through a distance of 10 m. If 25 J of work is performed, then the angle between the force and the direction of motion is
a) 0°   b) 90°   c) 30°   d) 60°

273. A bucket full of water weighs 5 kg, it is pulled from a well 20 m deep. There is a small hole in the bucket through which water leaks at a constant rate of $0.2 kgm^{-1}$ .The total work done in pulling the bucket up from the well is ($g = 10ms^{-2}$)
a) 600 J   b) 400 J   c) 100 J   d) 500 J

274. The work done by force acting on a body is as shown in the graph. The total work done in covering an initial distance of 20 m is

(graph: F(N) vs s(m); F axis marked 5, 10, H20, M15; s axis marked X 0, N5, 010, 15, 20, 25, E30)
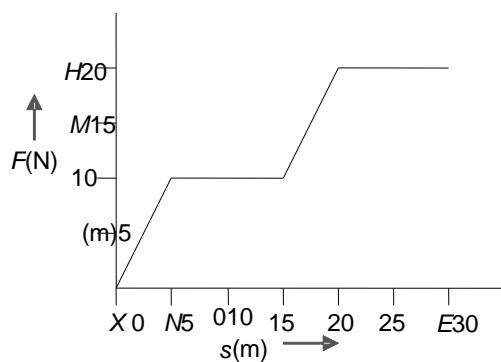
a) 225J   b) 200J   c) 400J   d) 175J

275. Natural length of a spring is 60 cm, and its spring constant is 4000 N/m. A mass of 20 kg is hung from it. The extension produced in the spring is, (Take $g = 9.8\ m/s^2$)

a) 4.9 cm   b) 0.49 cm   c) 9.4 cm   d) 0.94 cm

276. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?
   a) 7.2 J   b) 3.6 J   c) 120 J   d) 1200 J

277. A body moving with velocity v has momentum and kinetic energy numerically equal. What is the value of v
   a) 2 m/s   b) $\sqrt{2}$ m/s   c) 1 m/s   d) 0.2 m/s

278. Power supplied to a particle of mass 2 kg varies with time as $P = \frac{3t^2}{2}$ watt. Here t is in second. If the velocity of particle at $t = 0$ is $v = 0$, the velocity of particle at time $t = 2$ s will be
   a) 1 ms^{-1} b) 4 ms^{-1} c) 2 ms^{-1} d) $2\sqrt{2}$ ms^{-1}

279. When a spring is extended by 2 cm energy stored is 100 J. When extended by further 2 cm, the energy increases by
   a) 400 J   b) 300 J   c) 200 J   d) 100 J

280. A steel ball of mass 5 g is thrown downward with velocity 10 ms^{-1} from height 19.5 m. It penetrates sand by 50 cm. The change in mechanical energy will be (g $= 10$ms^{-2})
   a) 1 J   b) 1.25 J   c) 1.5 J   d) 1.75 J

281. Two springs of spring constants 1500 N/m and 3000 N/m respectively are stretched with the same force. They will have potential energy in the ratio
   a) 4 : 1   b) 1 : 4   c) 2 : 1   d) 1 : 2

282. A river of salty water is flowing with a velocity 2 ms^{-1} If the density of the water is 1.2 g/cc, then the kinetic energy of each cubic metre of water is
   a) 2.4 J   b) 24 J   c) 2.4 KJ   d) 4.8 KJ

283. A neutron makes a head-on elastic collision with a stationary deuteron. The fractional energy loss of the neutron in the collision is
   a) 16/81   b) 8/9   c) 8/27   d) 2/3

284. Two bodies of masses 0.1 kg and 0.4 kg move towards each other with the velocities 1 m/s and 0.1 m/s respectively, After collision they stick together. In 10 sec the combined mass travels
   a) 120 m b) 0.12 m c) 12 m d) 1.2 m

285. The kinetic energy of a body is increased by 300%. What is the percentage increase in the momentum of the body?
   a) 50%   b) 100%   c) 150%   d) 200%

286. The area of the acceleration-displacement curve of a body gives
   a) Impulse   b) Change in momentum per unit mass
   c) Change in KE per unit mass   d) Total change in energy

287. A neutron travelling with a velocity v and K.E. E collides perfectly elastically head on with the nucleus of an atom of mass number A at rest. The fraction of total energy retained by neutron is
   a) $\left(\frac{A-1}{A+1}\right)^2$ b) $\left(\frac{A+1}{A-1}\right)^2$ c) $\left(\frac{A-1}{A}\right)^2$ d) $\left(\frac{A+1}{A}\right)^2$

288. A body of mass $2kg$ makes an elastic collision with another body at rest and continues to move in the original direction with one fourth of its original speed. The mass of the second body which collides with the first body is
   a) 2 kg b) 1.2 kg c) 3 kg d) 1.5 kg

289. The potential energy of a 1 kg particle free to move along the x-axis is given by $V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right)$ J.The total mechanical energy of particle is 2 J. Then, the maximum speed (in ms^{-1}) is
   a) $3/\sqrt{2}$ b) $\sqrt{2}$ c) $1/\sqrt{2}$ d) 2

290. A running man has half the kinetic energy of that of a boy of half of his mass. The man speeds up by $1m/s$ so as to have same $K.E.$ as that of the boy. The original speed of the man will be
   a) $\sqrt{2}$ m/s   b) $(\sqrt{2}-1)$ m/s   c) $\frac{1}{(\sqrt{2}-1)}$ m/s   d) $\frac{1}{\sqrt{2}}$ m/s

291. The potential energy of a particle of mass 5 kg moving in the $x - y$ plane is given by $U = (-7x + 24y)$ J, x

and y being in metre. Initially at $t = 0$ the particle is at the origin $(0, 0)$ moving with a velocity of $(2.4\hat{\mathbf{i}} + 0.7\hat{\mathbf{j}})$ms $^{-1}$. The magnitude of force on the particle is

a) 25 units
b) 24 units
c) 7 units
d) None of these

292. A shell is fired from a cannon with velocity $v\ m/sec$ at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed in m/sec of the other piece immediately after the explosion is

a) $3v\cos\theta$
b) $2v\cos\theta$
c) $\dfrac{3}{2}v\cos\theta$
d) $\dfrac{\sqrt{3}}{2}v\cos\theta$

293. A particle of mass m moving with a velocity $\vec{V}$ makes a head on elastic collision with another particle of same mass initially at rest. The velocity of first particle after the collision will be

a) $\vec{V}$
b) $-\vec{V}$
c) $-2\vec{V}$
d) Zero

294. A cubical vessel of height 1 m is full of water. what is the amount of work done in pumping water out of the vessel?(Take g=$10ms^{-2}$)

a) 1250 J
b) 5000 J
c) 1000 J
d) 2500 J

295. A force of(5+3x)N acting on a body of mass 20 kg along the x-axis displaces it from x=2m to x=6m.The

Work done by the force is

a) 20 J
b) 48 J
c) 68 J
d) 86 J

296. A simple pendulum is released from A as shown. If m and l represent the mass of the bob and length of the pendulum, the gain in kinetic energy at B is
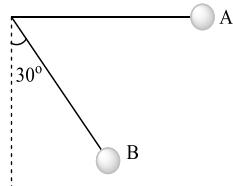
a) $\dfrac{mgl}{2}$
b) $\dfrac{mgl}{\sqrt{2}}$
c) $\dfrac{\sqrt{3}}{2}mgl$
d) $\dfrac{\sqrt{2}}{3}mgl$

297. A long spring is stretched by 2 cm and its potential energy is U. If the spring is stretched by 10 cm; its potential energy will be

a) U/5
b) U/25
c) 5 U
d) 25 U

298. If the heart pushes 1 cc of blocked in one second under pressure 20000 N/m^2 the power of heart is

a) $0.02\ W$
b) $400\ W$
c) $5 \times 10^{-10}\ W$
d) $0.2\ W$

299. Two balls of masses 2 g and 6 g are moving with KE in the ratio of 3:1. What is the ratio of their linear momenta?

a) 1:1
b) 2:1
c) 1:2
d) None of these

300. A neutron moving with velocity v collides with a stationary $\alpha - particle$.The velocity of the neutron after the collision is

a) $-\dfrac{3v}{5}$
b) $\dfrac{3v}{5}$
c) $\dfrac{2v}{5}$
d) $-\dfrac{2v}{5}$

301. A particle moves along the x$-axis$ from x= $x_1\ to\ x = x_2$ under the action of a force given by F=$2x$. Then the work done in the process is

a) Zero
b) $x_2^2 - x_1^2$
c) $2x_2(x_2 - x_1)$
d) $2x_1(x_1 - x_2)$

302. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36kg and 0.72kg.Taking g=$10ms^{-2}$,find the work done (in joule)by string on the block of mass 0.36kg during the first second after the system is released from rest .

a) 8 J   b) 9 J   c) 7 J   d) 0.48 J

303. A box is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to

a) $1^{1/2}$ b) $t^{3/4}$ c) $t^{3/2}$ d) t^2

304. In elastic collision

a) Both momentum and kinetic energies are conserved

b) Both momentum and kinetic energies are not conserved

c) Only energy is conserved

d) Only mechanical energy is conserved

305. From a waterfall, water is falling down at the rate of 100 kg/s on the blades of turbine. If the height of the ball is 100 m, then the power delivered to the turbine is approximately equal to

a) 100 kW b) 10 kW c) 1 kW d) 1000 kW

306. A 2 kg ball moving at $24 ms^{-1}$ undergoes inelastic head-on collision with a 4 kg ball moving in opposite direction at 48 ms^{-1}.if the coefficient of restitution is 2/3,their velocities in ms^{-1} after impact are

a) $-56, -8$ b) $-28, -4$ c) $-14, -2$ d) $-7, -1$

307. The displacement x in metre of a particle of mass m kg moving in one dimension under the action of a force is related to the time t in second by the equation $t = \sqrt{x} + 3$, the work done by the force (in joule) in first six seconds is

a) 18 m b) Zero   c) 9 $m/2$ d) 36 m

308. A wooden block of mass M rests on a horizontal surface. A bullet of mass m moving in the horizontal direction strikes and gets embedded in it. The combined system covers a distance x on the surface. If the coefficient of friction between wood and the surface is μ,the speed of the bullet at the time of striking the block is (where m is mass of the bullet)

a) $\sqrt{\dfrac{2Mg}{\mu m}}$ b) $\sqrt{\dfrac{2\mu mg}{Mx}}$ c) $\sqrt{2\mu gx}\left(\dfrac{M+m}{m}\right)$ d) $\sqrt{\dfrac{2\mu mx}{M+m}}$

309. An engine pumps up 100kg of water through a height of 10 m in 5 s. Given that the efficiency of engine is 60%.

If g=$10 ms^{-2}$,the power of the engine is

a) 3.3 KW   b) 0.33 KW   c) 0.033KW   d) 33KW

310. A 60 kg man runs up a staircase in 12 seconds while a 50 kg man runs up the same staircase in 11 seconds. The ratio of the rate of doing their work is

a) 6 : 5   b) 12 : 11   c) 11 : 10   d) 10 : 11

311. A body of mass 4 kg moving with velocity 12 m/s collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is

a) Zero   b) 288 J c) 172.8 J d) 144 J

312. A man starts walking from a point on the surface of earth (assumed smooth) and reaches diagonally opposite point. What is the work done by him

a) Zero   b) Positive   c) Negative   d) Nothing can be done

313. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and $2v$, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A
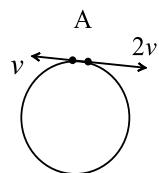
a) 4   b) 3   c) 2   d) 1

314. A spring, which is initially in its unstretched condition, is first stretched by a length x and then again by a further length x.The work done in the first case is w_1, and in the second case is w_2. Then

a) $W_2 = W_1$ b) $W_2 = 2W_1$ c) $w_2 = 3w_1$ d) $w_2 = 4w_1$

315. From a building two balls A to B are thrown such that A is thrown upwards and B downwards (both vertically). If v_A and v_B are their respective velocities on reaching the ground, then
    a) $v_B > v_A$ b) $v_B = v_A$
   c) $v_A > v_B$ d) Their velocities depends on their masses

316. What power must a sprinter, weighing 80 kg, develop from the start if he has to impart a velocity of $10 \ \text{ms}^{-1}$ to his body in 4 s?
    a) 1 kW   b) 2 kW   c) 3 kW   d) 4 kW

317. A light and a heavy body have equal momenta. Which one has greater K.E.
    a) The light body   b) The heavy body   c) The K.E. are equal   d) Data is incomplete

318. Six identical balls are linked in a straight groove made on a horizontal frictionless surface as shown. Two similar balls each moving with a velocity v collide elastically with the row of 6 balls from left. What will happen
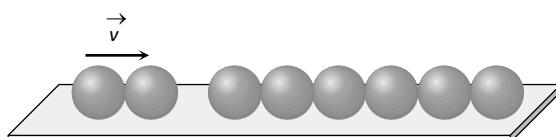
    a) One ball from the right rolls out with a speed $2v$ and the remaining balls will remain at rest
    b) Two balls from the right roll out with speed v each and the remaining balls will remain stationary
    c) All the six balls in the row will roll out with speed $v/6$ each and the two colliding balls will come to rest
    d) The colliding balls will come to rest and no ball rolls out from right

319. A body of mass m_1, moving with a velocity $3 \ ms^{-1}$ collides with another body at rest of mass m_2. After collision the velocities of the two bodies are $2 \ ms^{-1}$ and $5 \ ms^{-1}$ respectively along the direction of motion of m_1 The ratio m_1/m_2 is
    a) $\dfrac{5}{12}$ b) 5 c) $\dfrac{1}{5}$ d) $\dfrac{12}{5}$

320. A ball hits the floor and rebounds after inelastic collision. In this case
    a) The momentum of the ball just after the collision is the same as that just before the collision
    b) The mechanical energy of the ball remains the same in the collision
    c) The total momentum of the ball and the earth is conserved
    d) The total energy of the ball and the earth is conserved

321. If a body looses half of its velocity on penetrating $3 \ cm$ in a wooden block, then how much will it penetrate more before coming to rest
    a) $1 \ cm$ b) $2 \ cm$ c) $3 \ cm$ d) $4 \ cm$

322. Under the action of a force F=Cx, the position of a body changes from 0 to x. The work done is
    a) $\dfrac{1}{2}Cx^2$ b) Cx^2 c) Cx d) $\dfrac{1}{2}Cx$

323. A block of mass m at the end of the string is whirled round a vertical circle of radius r. The critical speed of the block at the top of the swing is
    a) $\left(\dfrac{r}{g}\right)^{1/2}$ b) $\dfrac{g}{r}$ c) $\dfrac{m}{rg}$ d) $(rg)^{1/2}$

324. A man running has half the kinetic energy of a boy of half his mass. The man speeds up by 1 ms^{-1} and then has KE as that of the boy. What were the original speeds of man and the boy?
    a) $\sqrt{2}$ms^{-1}; $2\sqrt{2} - 1$ms^{-1} b) $(\sqrt{2} - 1)$ms^{-1}, $2(\sqrt{2} - 1)$ms^{-1}
    c) $(\sqrt{2} + 1)$ms^{-1}; $2(\sqrt{2} + 1)$ms^{-1} d) None of the above

325. A body of mass m having an initial velocity v, makes head on collision with a stationary body of mass M. After the collision, the body of mass m comes to rest and only the body having mass M moves. This will happen only when
    a) $m \gg M$ b) $m \ll M$ c) $m = M$ d) $m = \dfrac{1}{2}M$

326. A rifle bullet loses $1/20^{\text{th}}$ of its velocity in passing through a plank. The least number of such planks

required just to stop the bullet is
a) 5   b) 10   c) 11   d) 20

327. When U^{238} nucleus originally at rest, decays by emitting an alpha particle having a speed u The recoil speed of the residual nucleus is

a) $\dfrac{4u}{238}$ b) $-\dfrac{4u}{234}$ c) $\dfrac{4u}{234}$ d) $-\dfrac{4u}{238}$

328. The diagrams represent the potential energy U of a function of the inter-atomic distance r. Which diagram corresponds to stable molecules found in nature

a)   b)   c)   d)
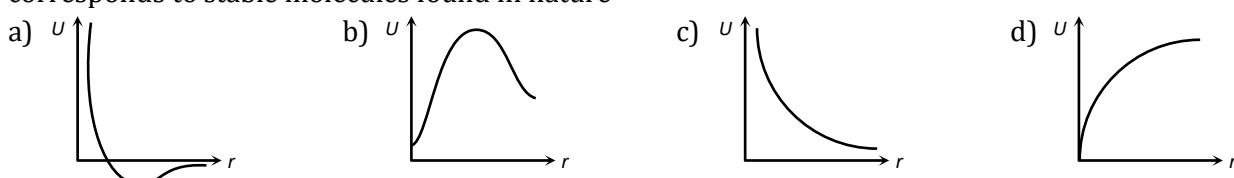
329. A body of mass 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction ($g = 10\ m/s^2$)
a) 20 J b) 30 J c) 40 J d) 10 J

330. A bullet when fired at a target with velocity of 100 ms^{-1} penetrates 1 m into it. If the bullet is fired at a similar target with a thickness 0.5m, then it will emerge from it with a velocity of

a) $50\sqrt{2}$ m/s   b) $\dfrac{50}{\sqrt{2}}$ m/s   c) 50 m/s   d) 10 m/s

331. A force of 5 N acts on a 15 kg body initially at rest. The work done by the force during the first second of motion of the body is

a) 5 J b) $\dfrac{5}{6}\,J$ c) 6 J d) 75 J

332. The velocity of 2 kg body is changed from $(4\hat{\imath} + 3\hat{\jmath})$ ms^{-1}. The work done on the body is
a) 9 J   b) 11 J   c) 1 J   d) Zero

333. A body at rest explodes into two equal parts. Then,
a) They move with different speeds in different directions.
b) They move with different speeds in same direction
c) They move with same speed in same directions
d) They move with same speed in opposite directions

334. A particle of mass m is moving in a circular path of constant radius r such that its centripctal acceleration a_c is varying with time t as $a_c = k^2 r t^2$. the power is

a) $2\pi m k^2 r^2 t$ b) $m k^2 r^2 t$ c) $\dfrac{m k^4 r^2 t^5}{3}$ d) Zero

335. A particle is released from a height S. At certain height its kinetic energy is three times its potential energy .The height and speed of the particle at that instant are respectively

a) $\dfrac{S}{4}, \dfrac{3gS}{2}$ b) $\dfrac{S}{4}, \dfrac{\sqrt{3gS}}{2}$ c) $\dfrac{S}{2}, \dfrac{\sqrt{3gS}}{2}$ d) $\dfrac{S}{4}, \sqrt{\dfrac{3gS}{2}}$

336. A spring of spring constant 5×10^3 Nm^{-1} is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is
a) 12.50 N-m   b) 18.75 N-m   c) 25.00 N-m   d) 6.25 N-m

337. A 10 kg brick moves along an x-axis. Its acceleration as a function of its position is shown in figure. What is the net work performed on the brick by the force causing the acceleration as the brick moves from $x = 0$ to $x = 8.0$m?

a) 4 J   b) 8 J   c) 2 J   d) 1 J
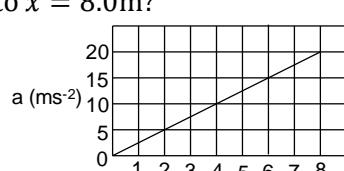
338. An athlete in the Olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range
a) $2 \times 10^5 J - 3 \times 10^5 J$ b) $20,000\ J - 50,000\ J$ c) $2,000\ J - 5,000\ J$ d) $200\ J - 500\ J$

339. The graph between the resistive force F acting on a body and the distance covered by the body is shown in figure. The mass of the body is 25 kg and initial velocity is 2 m/s. When the distance covered by the body is $4m$, its kinetic energy would be

a) 50 J b) 40 J c) 20 J d) 10 J

340. A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest
a) At the instant just after the body is projected   b) At the highest position of the body
c) At the instant just before the body hits the earth   d) It remains constant all through

341. Two masses m_A and m_B moving with velocities v_A and v_B in opposite directions collide elastically. After that the masses m_A and m_B move with velocity v_B and v_A respectively. The ratio (m_A/m_B) is
a) 1
b) $\dfrac{v_A - v_B}{v_A + v_B}$
c) $(m_A + m_B)/m_A$
d) v_A/v_B

342. Two equal masses m_1 and m_2 moving along the same straight line with velocities $+3\ m/s$ and $-5\ m/s$ respectively collide elastically. Their velocities after the collision will be respectively
a) $+4\ m/s$ for both   b) $-3\ m/s$ and $+5\ m/s$ c) $-4\ m/s$ and $+4\ m/s$ d) $-5\ m/s$ and $+3\ m/s$

343. The human heart discharges 75 cc of blood through the arteries at each beat against an average pressure of 10 cm of mercury. Assuming that the pulse frequency is 72 per minute the rate of working of heart in watt, is (Density of mercury =13.6 g/cc and g = 9.8 ms^{-2})
a) 11.9   b) 1.19   c) 0.119   d) 119

344. An engineer claims to have made an engine delivering 10 KW power with fuel consumption of 1 gs^{-1}. The calorific value of fuel is $2kcalg^{-1}$. This claim is
a) Valid   b) Invalid
c) Dependent o engine design   d) Dependent on load

345. A bullet hits and gets embedded in a solid block resting on a horizontal frictionless table. What is conserved
a) Momentum and kinetic energy   b) Kinetic energy alone
c) Momentum alone   d) Neither momentum nor kinetic energy

346. A body of mass 3 kg is under a force, which causes a displacement in it given by $S = \dfrac{t^3}{3}$ (in m). Find the work done by the force in first 2 seconds
a) 2 J b) 3.8 J c) 5.2 J d) 24 J

347. A body of mass m accelerates uniformly from rest to v_1 in time t_1. As a function of time t, the instantaneous power delivered to the body is
a) $\dfrac{mv_1 t}{t_1}$
b) $\dfrac{mv_1^2 t}{t_1}$
c) $\dfrac{mv_1 t^2}{t_1}$
d) $\dfrac{mv_1^2 t}{t_1^2}$

348. A mass of $M\ kg$ is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is
a) $Mg\sqrt{2}$
b) $\dfrac{Mg}{\sqrt{2}}$
c) $Mg(\sqrt{2} - 1)$
d) $Mg(\sqrt{2} + 1)$

349. A motor of power p_0 is used to deliver water at a certain rate through a given horizontal pipe. To increase the rate of flow of water through the same pipe n times, the power of the motor is increased to p_1. The ratio of p_1 to p_0 is
a) $n : 1$ b) $n^2 : 1$ c) $n^3 : 1$ d) $n^4 : 1$

350. A particle of mass 100 g is thrown vertically upwards with a speed of $5ms^{-1}$. The work done by the force

of gravity during the time, the particle goes up is

a) -0.5 J b) -1.25 J c) 1.25 J d) 0.5 J

351. Two springs have their force constants as k_1 and $k_2 (k_1 > k_2)$, when they are stretched by the same force
   a) No work is done in case of both the springs   b) Equal work is done in case of both the springs
   c) More work is done in case of second spring   d) More work done in case of first spring

352. When two bodies collide elastically, then
   a) Kinetic energy of the system alone is conserved
   b) Only momentum is conserved
   c) Both energy and momentum are conserved
   d) Neither energy nor momentum is conserved

353. A body of mass 2 kg moving with a velocity of $3\ ms^{-1}$ collides head on with a body of mass 1 kg moving in opposite direction with a velocity of $4ms^{-1}$. After collision two bodies stick together and move with a common velocity which in ms^{-1} is equal to

   a) $\dfrac{1}{4}$ b) $\dfrac{1}{3}$ c) $\dfrac{2}{3}$ d) $\dfrac{3}{4}$

354. In the non-relativistic regime, if the momentum, is increased by 100%, the percentage increase in kinetic energy is
   a) 100 b) 200 c) 300 d) 400

355. A variable force, given by the 2-dimensional vector $\vec{F} = (3x^2\hat{\imath} + 4\,\hat{\jmath})$, acts on a particle. The force is in newton and x is in metre. What is the change in the kinetic energy of the particle as it moves from the point with coordinates (2,3) to (3,0) (The coordinates are in metres)
   a) $-7\ J$ b) Zero c) $+7\ J$ d) $+19\ J$

356. At a certain instant, a body of mass 0.4 kg has a velocity of $(8\hat{\imath} + 6\hat{\jmath})$ms^{-1}. The kinetic energy of the body is
   a) 10 J b) 40 J c) 20 J d) None of these

357. An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension in the spring is

   a) $\dfrac{4Mg}{k}$ b) $\dfrac{2Mg}{k}$ c) $\dfrac{Mg}{k}$ d) $\dfrac{Mg}{2k}$

358. Two springs A and B are stretched by applying forces of equal magnitudes at the four ends. If spring constant of A is 2 times greater than that of spring B, and the energy stored in A is E, that in B is

   a) $\dfrac{E}{2}$ b) $2E$ c) E d) $\dfrac{E}{4}$

359. A spring with spring constant k when stretched through $1\ cm$, the potential energy is U. If it is stretched by $4\ cm$. The potential energy will be
   a) $4U$ b) $8U$ c) $16U$ d) $2U$

360. The force required to stretch a spring varies with the distance as shown in the figure. If the experiment is performed with above spring of half length, the line OA will
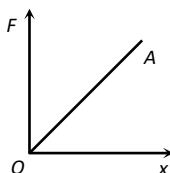
   a) Shift towards F-axis   b) Shift towards X-axis
   c) Remain as it is   d) Become double in length

361. Two balls at same temperature collide. What is conserved
   a) Temperature b) Velocity c) Kinetic energy d) Momentum

362. A rod AB of mass M, length L is lying on a horizontal frictionless surface. A particle of mass m travelling along the surface hits the end A of the rod with a velocity v_0 in a direction perpendicular to AB. The collision is completely elastic. After the collision, the
   Particle comes to rest. The ratio $\dfrac{m}{M}$ Is

a) $\dfrac{\omega^2 L^2}{9v_0^2}$ 　　　　b) $\dfrac{9v_0^2}{\omega^2 L^2}$ 　　　　c) $\dfrac{9v_0}{\omega L}$ 　　　　d) $\dfrac{\omega L}{9v_0}$

363. A body moving with velocity v has momentum and kinetic energy numerically equal. What is the value of v?

a) $2ms^{-1}$ 　　　　b) $\sqrt{2}ms^{-1}$ 　　　　c) $1ms^{-1}$ 　　　　d) $0.2ms^{-1}$

364. The force constant of a weightless spring is $16\ N/m$. A body of mass $1.0\ kg$ suspended from it is pulled down through 5 cm and then released. The maximum kinetic energy of the system (spring + body) will be

a) $2 \times 10^{-2}\ J$ 　　　　b) $4 \times 10^{-2}\ J$ 　　　　c) $8 \times 10^{-2}\ J$ 　　　　d) $16 \times 10^{-2}\ J$

365. A plate of mass m, length b and breadth a is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor. The work done to erect it on its breadth is

a) $mg\left[\dfrac{b}{2}\right]$ 　　　　b) $mg\left[a + \dfrac{b}{2}\right]$ 　　　　c) $mg\left[\dfrac{b - a}{2}\right]$ 　　　　d) $mg\left[\dfrac{b + a}{2}\right]$

366. A 16 kg block moving on a frictionless horizontal surface with a velocity of 4 m/s compresses an ideal spring and comes to rest. If the force constant of the spring be 100 N/m, then the spring is compressed by

a) 1.6 m 　　　　b) 4 m 　　　　c) 6.1 m 　　　　d) 3.2 m

367. A body of mass m_1 collides elastically with another body of mass m_2 at rest .If the velocity of m_1 after collision becomes 2/3 times its initial velocity, the ratio of their masses, is

a) 1:5 　　　　b) 5:1 　　　　c) 5:2 　　　　d) 2:5

368. In a certain situation, $\vec{F}$ and $\vec{s}$ are not equal to zero but the work done is zero. From this, we conclude that

a) $\vec{F}$ and $\vec{s}$ are in same direction 　　　　b) $\vec{F}$ and $\vec{s}$ are in opposite direction

c) $\vec{F}$ and $\vec{s}$ are at right angles 　　　　d) $\vec{F} > \vec{s}$

369. An electric pump is used to fill an overhead tank of capacity $9m^3$ kept at a height of 10 m above the ground .If the pump takes 5 min to fill the tank by consuming 10 KW .power the efficiency of the pump should be (Take g=10 ms^{-2})

a) 60 % 　　　　b) 40 % 　　　　c) 20 % 　　　　d) 30 %

370. A nucleus at rest splits into two nuclear parts having same density and radii in the ratio 1:2. Their velocities are in the ratio

a) $2:1$ 　　　　b) $4:1$ 　　　　c) $6:1$ 　　　　d) $8:1$

371. The power of a water jet flowing through an orifice of radius r with velocity v is

a) Zero 　　　　b) $500\ \pi r^2 v^2$ 　　　　c) $500\ \pi r^2 v^3$ 　　　　d) $\pi r^4 v$

372. If two balls each of mass $0.06\ kg$ moving in opposite directions with speed $4\ m/s$ collide and rebound with the same speed, then the impulse imparted to each ball due to other is

a) $0.48\ kg\text{-}m/s$ 　　　　b) $0.24\ kg\text{-}m/s$ 　　　　c) $0.81\ kg\text{-}m/s$ 　　　　d) Zero

373. A ship weighing 0.3×10^8 kg-wt is pulled by a force of 0.5×10^5 N through a distance of 3 m. If the ship were originally at rest and water-resistance is negligibly small, then the ship will acquire a speed of

a) 0.1 ms^{-1} 　　　　b) 1 ms^{-1} 　　　　c) 1.5 ms^{-1} 　　　　d) 12 ms^{-1}

374. A force of $2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}\ N$ acts on a body for 4 second, produces s displacement of $\left(3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}\right)m$. The power used is

a) $9.5\ W$ 　　　　b) $7.5\ W$ 　　　　c) $6.5\ W$ 　　　　d) $4.5\ W$

375. When a spring is stretched by a distance x,it exerts a force,given by $F = (-5x - 16x^3)$N
The work done ,when the spring is stretched from 0.1 m to 0.2 m is

a) 8.7×10^{-2}J 　　　　b) 12.2×10^{-2}J 　　　　c) $8.7 \times 10^{-1}\ J$ 　　　　d) 12.2×10^{-1}J

376. The potential energy of a particle of mass 5 kg moving in the $x - y$ plane is given by $U = (-7x + 24y)$ J, x and y being in metre. If the particle starts from rest from origin then speed of particle at $t = 2$ s is

a) 5 ms^{-1} 　　　　b) 01 ms^{-1} 　　　　c) 17.5 ms^{-1} 　　　　d) 10 ms^{-1}

377. A one kilowatt motor is used to pump water from a well 10 m deep. The quantity of water pumped out per second is nearly

a) 1 kg   b) 10 kg   c) 100 kg   d) 1000 kg

378. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are $v \ and \ 2v$ respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A ,these two particles will again reach The point A?
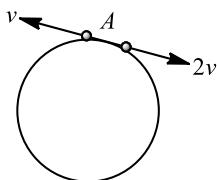

a) 4   b) 3   c) 2   d) 1

379. The potential energy of a system increases if work is done
   a) Upon the system by a conservative force   b) Upon the system by a non-conservative force
   c) By the system against a conservative force   d) By the system against a non-conservative force

380. A force $(4\hat{\imath} + \hat{\jmath} - 2\hat{k})N$ acting on a body maintains its velocity at $(2\hat{\imath} + 2\hat{\jmath} + 3\hat{k})ms^{-1}$. The power exerted is
   a) 4 W   b) 5 W   c) 2 W   d) 8 W

381. Figure shows the F-x graph. Where F is the force applied and x is the distance covered
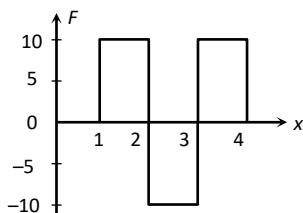
   By the body along a straight line path. Given that F is in $newton$ and x in $metre$, what is the work done?
   a) 10 J b) 20 J c) 30 J d) 40 J

382. If a skater of weight 3 kg has initial speed 32 m/s and second one of weight 4 kg has 5 m/s. After collision, they have speed (couple) 5 m/s. Then the loss in K.E. is
   a) 48 J b) 96 J c) Zero   d) None of these

383. The area under the displacement-force curve gives
   a) Distance travelled   b) Total force   c) Momentum   d) Work done

384. A body of mass 2 kg slides down a curved track which is quadrant of a circle of radius 1 $metre$. All the surfaces are frictionless. If the body starts from rest, its speed at the bottom of the track is
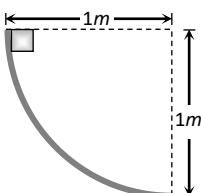

   a) 4.43 m/sec b) 2 m/sec c) 0.5 m/sec d) 19.6 m/sec

385. The work done against gravity in taking 10 kg mass at 1m height in 1 sec will be
   a) 49 J b) 98 J c) 196 J d) None of these

386. A vertical spring with force constant K is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is
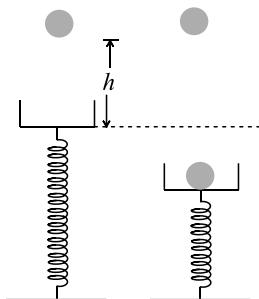
a) $mg + (h + d) + \frac{1}{2}Kd^2$ b) $mg(h + d) - \frac{1}{2}Kd^2$

c) $mg(h - d) - \frac{1}{2}Kd^2$ d) $mg(h - d) + \frac{1}{2}Kd^2$

387. A body of mass 2 kg collides with a wall with speed 100 m/s and rebounds with same speed. If the time of contact was 1/50 second, the force exerted on the wall is

a) 8 N b) 2×10^4 N c) 4 N d) 10^4 N

388. The power of pump, which can pump 200 kg of water to a height of 50 m in 10 sec, will be

a) 10×10^3 $watt$ b) 20×10^3 $watt$ c) 4×10^3 $watt$ d) 60×10^3 $watt$

389. A ball moving with speed v hits another identical ball at rest. The two balls stick together after collision. If specific heat of the material of the balls is S, the temperature rise resulting from the collision is

a) $\frac{v^2}{8S}$ b) $\frac{v^2}{4S}$ c) $\frac{v^2}{2S}$ d) $\frac{v^2}{S}$

390. The work done by a force $\vec{F} = (-6x^3 i)N$, in displacing a particle from $x = 4\ m$ to $x = -2\ m$ is

a) 360 J b) 240 J c) $-240\ J$ d) $-360\ J$

391. According to work-energy theorem, the work done by the net force on a particle is equal to the change in its

a) Kinetic energy   b) Potential energy   c) Linear momentum   d) Angular momentum

392. A boy of mass 1 kg moves from point $A(2m, 3m, 4m)$ to $B(3m, 2m, 5m)$. During motion of body, a force $\vec{F} = (2N)\hat{i} - (4N)\hat{j}$ acts on it. The work done by the force on the particle displacement is

a) $(2\hat{i} - 4\hat{j})J$ b) 2 J   c) -2 J   d) None of these

393. A particle moves in a straight line with retardation proportional to its displacement. Its loss of KE for any displacement x is proportional to

a) x b) x^2 c) x^0 d) e^x

394. A body is moved along a straight line by machine delivering a constant power. The distance moved by the body in time t is proportional to

a) $t^{3/4}$ b) $t^{3/2}$ c) $t^{1/4}$ d) $t^{1/2}$

395. A ball of mass 2 kg moving with velocity 3 ms^{-1}, collides with spring of natural length 2 m and force constant 144 Nm^{-1}. what will be length of compressed spring?

a) 2 m   b) 1.5 m   c) 1 m   d) 0.5 m

396. A ball is dropped from height 10 m. Ball is embedded in sand 1 m and stops, then

a) Only momentum remains conserved   b) Only kinetic energy remains conserved

c) Both momentum and K.E. are conserved   d) Neither K.E. nor momentum is conserved

397. Ten litre of water per second is lifted from well through 20 m and delivered with a velocity of 10 ms^{-1}, then the power of the motor is

a) 1.5 kW   b) 2.5 kW   c) 3.5 kW   d) 4.5 kW

398. The power of a pump, which can pump 200 kg of water to a height of 200 m in $10sec$ is $(g = 10m/s^2)$

a) 40 kW b) 80 kW c) 400 kW d) 960 kW

399. A 50 kg man with 20 kg load on his head climbs up 20 steps of $0.25m$ height each. The work done in climbing is

a) 5 J b) 350 J c) 100 J d) 3430 J

400. Stopping distance of a moving vehicle is directly proportional to

a) Square of the initial velocity   b) Square of the initial acceleration

c) The initial velocity   d) The initial acceleration

401. If the kinetic energy of a body becomes four times of its initial value, then new momentum will

a) Becomes twice its initial value   b) Become three times its initial value

c) Become four times its initial value   d) Remains constant

402. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to

a) x^2 b) e^x c) x d) $\log_e x$

403. When a man increases his speed by 2 ms^{-1}, he finds that his kinetic energy is doubled, the original speed

of the man is

a) $2(\sqrt{2}-1)$ ms^{-1} b) $2(\sqrt{2}+1)$ ms^{-1} c) 4.5 ms^{-1} d) None of these

404. Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{v}_1$ and $\vec{v}_2$ respectively at time $t = 0$. They collide at time t_0. Their velocities becomes $\vec{v}_1'$ and $\vec{v}_2'$ at time $2t_0$ while still moving in air. The value of $\left|\left(m_1\vec{v}_1' + m_2\vec{v}_2'\right)\right| - (m_1\vec{v}_1 + m_2\vec{v}_2)$ is

a) Zero

b) $(m_1 + m_2)gt_0$ c) $2(m_1 + m_2)gt_0$ d) $\dfrac{1}{2}(m_1 + m_2)gt_0$

405. A spring of 40 mm long is stretched by the application of a force. If 10 N force required to stretch the spring through 1 mm, then work done in stretching the spring through 40 mm

a) 84 J b) 68 J c) 23 J d) 8 J

1 **(b)**

$\Delta U = mgh = 20 \times 9.8 \times 0.5 = 98\ J$

2 **(a)**

$\frac{1}{2}kS^2 = 10\ J$ [Given in the problem]

$\frac{1}{2}k[(2S)^2 - (S)^2] = 3 \times \frac{1}{2}kS^2 = 3 \times 10 = 30\ J$

3 **(b)**

Energy required $= mgh$

In both cases, h is the same. Hence, energy given by both is same. [It is worth noting here that powers of two men will be different as power is the energy expense per unit time and times are different]

4 **(d)**

$U = \dfrac{a}{x^{12}} - \dfrac{b}{x^6}$

$F = -\dfrac{dU}{dx} = +12\dfrac{a}{x^{13}} - \dfrac{6b}{x^7} = 0 \Rightarrow x = \left(\dfrac{2a}{b}\right)^{1/6}$

$U(x = \infty) = 0$

$U_{\text{equilibrium}} = \dfrac{a}{\left(\frac{2a}{b}\right)^2} - \dfrac{b}{\left(\frac{2a}{b}\right)} = \dfrac{b^2}{4a}$

$\therefore U(x = \infty) - U_{\text{equilibrium}} = 0 - \left(-\dfrac{b^2}{4a}\right) = \dfrac{b^2}{4a}$

5 **(d)**

Kinetic energy of particle ,$k = \dfrac{p_1^2}{2m}$

$p_1^2 = 2mk'$

When kinetic energy $=2k$

$p_2^2 = 2m \times 2k, p_2^2 = 2p_1^2, p_2 = \sqrt{2}p_1$

6 **(c)**

Radio in radius of steel balls $= 1/2$

So, ratio in the masses $= \frac{1}{8}$ [As $M \propto V \propto r^3$]

Let $m_1 = 8m$ and $m_2 = m$

$u_1 = 81\ cm/s \qquad u_2 = 0$
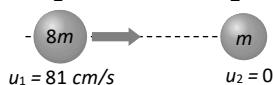
$v_2 = \dfrac{2m_1u_1}{m_1 + m_2} = \dfrac{2 \times 8m \times 81}{8m + m} = 144\ cm/s$

7 **(b)**

Gravitational force is a conservative force and work done against it is a point function $i.\,e.$ does not depend on the path

8 **(b)**

Initial momentum

$\vec{P} = m45\sqrt{2}\hat{\imath} + m45\sqrt{2}\hat{\jmath}$
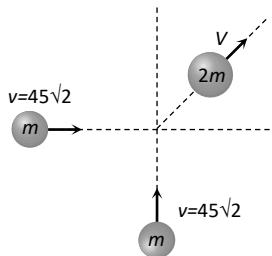
$\Rightarrow |\vec{P}| = m \times 90$

Final momentum $2m \times V$

By conservation of momentum

$2m \times V = m \times 90$

$\therefore V = 45\ m/s$

9 **(c)**

Given ,$t_1 = 10s,\quad t_2 = 20,\quad w_1 = w_2$

power$= \dfrac{work\ done}{time}$

or $\dfrac{p_1}{p_2} = \dfrac{w_1/t_1}{w_2/t_2}$

$\therefore \quad \dfrac{p_1}{p_2} = \dfrac{t_2}{t_1} = \dfrac{2}{1}$

10 **(b)**

$W = \dfrac{1}{2}kx^2$

If both wires are stretched through same distance then

$W \propto k$. As $k_2 = 2k_1$ so $W_2 = 2W_1$

11 **(b)**

For equilibrium

$\dfrac{dU}{dr} = 0 \Rightarrow \dfrac{-2A}{r^3} + \dfrac{B}{r^2} = 0$

$r = \dfrac{2A}{B}$

For stable equilibrium

$\dfrac{d^2U}{dr^2}$ should be positive for the value of r

Here $\dfrac{d^2U}{dr^2} = \dfrac{6A}{r^4} - \dfrac{2B}{r^3}$ is +ve value for $r = \dfrac{2A}{B}$

12 **(c)**

KE$= \frac{1}{2}mv^2 = \frac{1}{2}m(at)^2 = \frac{1}{2}ma^2t^2$

Rate of change of KE,

$\dfrac{dk}{dt} = \dfrac{d}{dt}\left(\dfrac{1}{2}ma^2t^2\right) = ma^2t$

$\because \dfrac{dk}{dt} \propto t$

So, statement A is correct.

When the body is at rest then it may be or may not be in equilibrium, so statement B is wrong.

14 **(b)**

Because the efficiency of machine is 90%, hence,

potential energy gained by the mass
$= \frac{90}{100} \times$ energy spend $= \frac{90}{100} \times 5000 = 4500$ J

When the mass is released now, gain in KE on hitting the ground
= Loss of potential energy
= 4500 J

15 **(d)**
$P = v \cos \theta = mg \, v \cos 90° = 0$

16 **(a)**
Power $= Fv = v \left(\frac{m}{t}\right) v = v^2 (\rho A v)$
$= \rho A v^3 = (100)(2)^3 = 800 \, W$

17 **(d)**
Potential energy of the particle $U = k(1 - e^{-x^2})$

Force on particle $F = \frac{-dU}{dx} = -k[-e^{-x^2} \times (-2x)]$

$F = -2kxe^{-x^2} = -2kx\left[1 - x^2 + \frac{x^4}{2!} - \cdots\right]$

For small displacement $F = -2kx$
$\Rightarrow F \propto -x \, i.e.$ motion is simple harmonic motion

18 **(a)**
Work done = Area under curve and displacement axis
= Area of trapezium
$= \frac{1}{2} \times$ (sum of two parallel lines)

$\qquad \times$ distance between them

$= \frac{1}{2}(10 + 4) \times (2.5 - 0.5) = \frac{1}{2}14 \times 2 = 14 \, J$

As the area actually is not trapezium so work done will be more than $14 \, J \, i.e.$ approximately $16 \, J$

19 **(c)**
As the block A moves with velocity with velocity $0.15 \, ms^{-1}$, it compresses the spring Which pushes B towards right. A goes on compressing the spring till the velocity acquired by B becomes equal to the velocity of A, i.e. $0.15 \, ms^{-1}$. Let this velocity be v. Now, spring is in a state of maximum compression. Let x be the maximum compression at this stage.
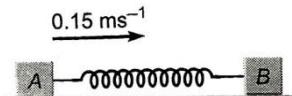
According to the law of conservation of linear momentum, we get
$m_A u = (m_A + m_B)v$
Or $v = \frac{m_A u}{m_A + m_B}$
$\frac{2 \times 0.15}{2 + 3} = 0.06 ms^{-1}$
According to the law of conservation of energy

$\frac{1}{2}m_A u^2 = \frac{1}{2}(m_A + m_B)V^2 + \frac{1}{2}kx^2$

$\frac{1}{2}m_A u^2 - \frac{1}{2}(m_A + m_B)v^2 = \frac{1}{2}kx^2$

$\frac{1}{2} \times 2 \times (0.15)^2 - \frac{1}{2}(2 + 3)(0.06)^2 = \frac{1}{2}kx^2$

$0.0225 - 0.009 = \frac{1}{2}kx^2$

$or \; 0.0135 = \frac{1}{2}kx^2$

Or $x = \sqrt{\frac{0.0027}{k}} = \sqrt{\frac{0.0027}{10.8}} = 0.05m$

20 **(b)**
Work done on the body = K.E. gained by the body
$Fs \cos \theta = 1 \Rightarrow F \cos \theta = \frac{1}{s} = \frac{1}{0.4} = 2.5N$

21 **(c)**
Velocity of fall is independent of the mass of the falling body

22 **(a)**
Volume of water to raise $= 22380 \, l = 22380 \times 10^{-3} m^3$

$P = \frac{mgh}{t} = \frac{V \rho gh}{t} \Rightarrow t = \frac{V \rho gh}{P}$

$t = \frac{22380 \times 10^{-3} \times 10^3 \times 10 \times 10}{10 \times 746} = 5 \, min$

23 **(d)**
$P = \frac{mgh}{t} \Rightarrow m = \frac{p \times t}{gh} = \frac{2 \times 10^3 \times 60}{10 \times 10}$
$\qquad = 1200 \, kg$

As volume $= \frac{mass}{density} \Rightarrow v = \frac{1200kg}{10^3 kg/m^3} = 1.2m^3$

Volume $= 1.2m^3 = 1.2 \times 10^3 \, litre = 1200 litre$

24 **(b)**
If ball falls from height h_1 and bounces back up to height h_2 then $e = \sqrt{\frac{h_2}{h_1}}$
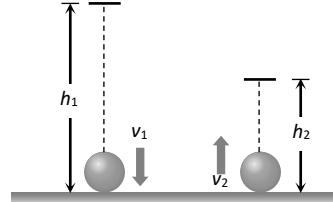
Similarly if the velocity of ball before and after collision are v_1 and v_2 respectively then $e = \frac{v_2}{v_1}$

So $\frac{v_2}{v_1} = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{1.8}{5}} = \sqrt{\frac{9}{25}} = \frac{3}{5}$

$i.e.$ fractional loss in velocity $= 1 - \frac{v_2}{v_1} = 1 - \frac{3}{5} = \frac{2}{5}$

25 **(c)**
$P = \frac{mgh}{t} = \frac{80 \times 10 \times 1.5}{2}$

$= 600 \text{ W} = 0.6 \text{ kW}$

26 **(c)**

Momentum of the third part will be equal to the resultant of momentum of two parts.

$$p_3 = \sqrt{p_1^2 + p_2^2}$$
$$p_3 = \sqrt{(-2p)^2 + p^2}$$
$$p_3 = p\sqrt{5}$$

27 **(a)**

$$U = \frac{1}{2}ks^2 = 10 \text{ J}$$
$$U' = \frac{1}{2}k(s+s)^2 = 4\left(\frac{1}{2}ks^2\right) = 40 \text{ J}$$
$$W = U' - U = 40 - 10 = 30 \text{ J}$$

28 **(a)**

$u_1 = 6m/s$ $\qquad$ $u_2 = 4m/s$
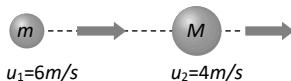
$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \frac{2m_2u_2}{m_1 + m_2}$$

Substituting $m_1 = 0$, $v_1 = -u_1 + 2u_2$
$\Rightarrow v_1 = -6 + 2(4) = 2 \ m/s$
i.e. the lighter particle will move in original direction with the speed of $2 \ m/s$

29 **(b)**

Let particle with mass m, move with velocity u,and v_1 and v_2 be velocity after collision. Since , elastic collision is one in which the momentum is conserved , we have
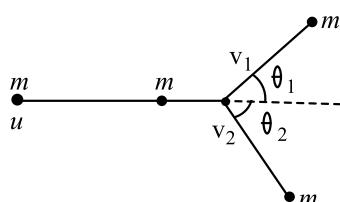
$\therefore mu = mv_1 \cos\theta_1 + mv_2 \cos\theta_2 \qquad \dots\text{(i)}$
In perpendicular direction
$0 = mv_1 \sin\theta_2 - mv_2 \sin\theta_2 \qquad \dots\text{(ii)}$
Also elastic collision occurs only if there is no conversion of kinetic energy into other from, Hence
$$\frac{1}{2}mu^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$$
$$u_2 = v_1^2 + v_2^2 \qquad \dots\text{(iii)}$$
Squaring Esq.(i)and (ii)and adding we get
$$m^2u^2 = m^2(v_1\cos\theta_1 + v_2\cos\theta_2)^2$$
$$+ m^2(v_1\sin\theta_1 - v_2\sin\theta_2)^2$$
$$u^2 = v_1^2 + v_2^2 + 2v_1v_2\cos\theta_1\cos\theta_2$$
$$\qquad\qquad - 2v_1v_2\sin\theta_1\sin\theta_2$$
$$u^2 = v_1^2 + v_2^2 + 2v_1v_2\cos(\theta_1 + \theta_2)$$
Using Eq.(iii),we get

$2v_1v_2\cos(\theta_1 + \theta_2) = 0$
since $\quad v_1v_2 \neq 0$
Hence $\quad \cos(\theta_1 + \theta_2) = 0$
Or $\qquad \theta_1 + \theta_2 = 90°$
When two identical particles collide elastically and obliquely,
One being at rest, then they fly off in mutually perpendicular directions.

30 **(c)**

$$1400 \times 10 \times 10 + W = \frac{1}{2} \times 15 \times 15$$

or $W = 700 \times 15 \times 15 - 1400 \times 10 \times 10$
or $W = 700(225 - 200) \text{ J}$
or $W = 700 \times 25 \text{ J} = 75.5 \text{ kJ}$

31 **(c)**

As the momentum of both fragments are equal therefore
$$\frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{3}{1} i.e., E_1 = 3E_2 \qquad \dots\text{(i)}$$
According to problem $E_1 + E_2 = 6.4 \times 10^4 \ J$
...(ii)
By solving equation (i) and (ii), we get
$E_1 = 4.8 \times 10^4 \ J$ and $E_2 = 1.6 \times 10^4 \ J$

32 **(a)**

Given, pressure$=20000 Nm^{-2}$
Volume$=1cc = 10^{-6}m^3$
$\because$Power=pressure×volume per second
$\therefore Power = 20000 \times 10^{-6}$
$p = 0.02 \ w$

33 **(d)**

Kinetic energy for first condition
$$= \frac{1}{2}m(v_2^2 - v_1^2) = \frac{1}{2}m(20^2 - 10^2) = 150 \ mJ$$
K.E. for second condition $= \frac{1}{2}m(10^2 - 0^2) = 50mJ$
$$\therefore \frac{(K.E.)I}{(K.E.)II} = \frac{150m}{50m} = 3$$

34 **(d)**
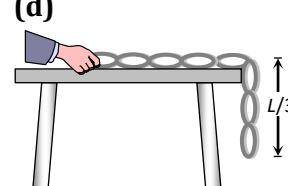
$$W = \frac{MgL}{2n^2} = \frac{MgL}{2(3)^2} = \frac{MgL}{18} \ [n = 3 \text{ Given }]$$

35 **(b)**

Force constant of a spring
$$k = \frac{F}{x} = \frac{mg}{x} = \frac{1 \times 10}{2 \times 10^{-2}} \Rightarrow k = 500 \ N/m$$
Increment in the length $= 60 - 50 = 10 \ cm$

$$U = \frac{1}{2}kx^2 = \frac{1}{2}500(10 \times 10^{-2})^2 = 2.5\,J$$

36 (c)

When a particle is moved in a circle under the action of a torque then such motion is non-uniform circular motion.

Applying principle of conservation of energy, total mechanical energy at L

= total mechanical energy at H
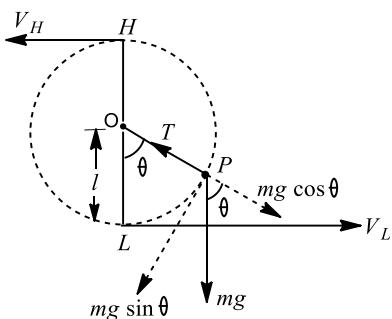
$$\therefore \frac{1}{2}mv_L^2 = \frac{1}{2}mv_H^2 + MG(2l)$$

But $v_H^2 = gl$

$$\therefore \frac{1}{2}mv_L^2 = \frac{1}{2}m(gl) + 2mgl$$

Or $v_L^2 = 5gl$

Or $v_L = \sqrt{5gl}$

Hence for looping the vertical loop, the minimum velocity at the lowest point L IS $\sqrt{5gl}$.

37 (b)
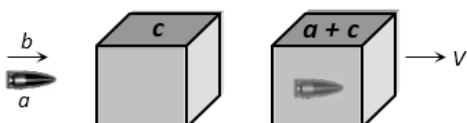
Initially bullet moves with velocity b and after collision bullet get embedded in block and both move together with common velocity

By the conservation of momentum

$$\Rightarrow a \times b + 0 = (a + c)V \Rightarrow V = \frac{ab}{a + c}$$

39 (b)

If the masses are equal and target is at rest and after collision both masses moves in different direction. Then angle between direction of velocity will be 90°, if collision is elastic

40 (d)

Work done (W) = Area under curve of F-x graph

= Area of triangle $OAB = \frac{1}{2} \times 5 \times 1 = 2.5$ J

41 (a)

$$E = \frac{1}{2}kx^2$$

$$\therefore \ E \propto k$$

$$\therefore \ \frac{E_1}{E_2} = \frac{k_1}{k_2}$$

42 (d)

$$W = \int_0^5 F dx = \int_0^5 (7 - 2x + 3x^2)dx$$

$$= [7x - x^2 + x^3]_0^5$$

$$= 35 - 25 + 125 = 135\,J$$

43 (b)

Minimum force $mg \sin\theta$, so, minimum power is given by

$$P = mg\sin\theta\, v \text{ or } v = \frac{P}{mg\sin\theta}$$

or $v = \frac{9000 \times 2}{1200 \times 10 \times 1}\,\text{ms}^{-1} = 15\text{ms}^{-1}$

$$= 15 \times \frac{18}{5} = 54\ \text{kmh}^{-1}$$

44 (d)

Here, the constant horizontal force required to take the body from position 1 to position 2 can be calculated by using work energy theorem. Let us assume that body taken slowly so that its speed doesn't change, then $\Delta K = 0$

$= W_F + W_{Mg} + W_{\text{tension}}$

(symbols have their usual meanings)

$W_F = F \times l\sin 45°$,

$W_{Mg} = Mg(l - l\cos 45°), W_{\text{tension}} = 0$

$\therefore \ F = Mg(\sqrt{2} - 1)$
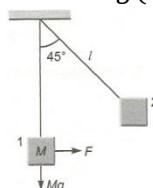
45 (a)

Since body moves with constant velocity, so. Net force on the body is zero.

Here, $N = mg, F = f$

$\therefore W = \vec{F}.\vec{s} = fs\cos 180''$

$= fs = -10 \times 2 = -20$ J

46 (a)

Spring constant $k = \frac{F}{x}$ = Slope of curve

$$\therefore k = \frac{4 - 1}{30} = \frac{3}{30} = 0.1\ kg/cm$$

47 (a)

$U_1 = mgh_1$ and $U_2 = mgh_2$

% energy lost $= \frac{U_1 - U_2}{U_1} \times 100$

$$= \frac{mgh_1 - mgh_2}{mgh_1}100 = \left(\frac{h_1 - h_2}{h_1}\right) \times 100$$

$$= \frac{2 - 1.5}{2} \times 100 = 25\%$$

48 (d)

It is clear from figure that the displacement vector $\Delta \vec{r}$ between particles p_1 and p_2 is $\Delta \vec{r} = \vec{r_2} - \vec{r_1} = -8\hat{\imath} - 8\hat{\jmath}$
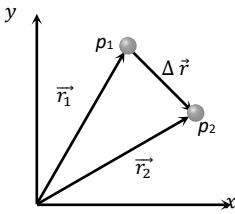
$|\Delta \vec{r}| = \sqrt{(-8)^2 + (-8)^2} = 8\sqrt{2}$ ....(i)

Now, as the particles are moving in same direction

($\because \vec{v_1}$ and $\vec{v_2}$ are $+ve$), the relative velocity is given by

$\vec{v}_{rel} = \vec{v_2} - \vec{v_1} = (\alpha - 4)\hat{\imath} + 4\hat{\jmath}$

$|\vec{v}_{rel}| = \sqrt{(\alpha - 4)^2 + 16}$ ...(ii)

Now, we know $|\vec{v}_{rel}| = \frac{|\Delta \vec{r}|}{t}$

Substituting the values of $\vec{v}_{rel}$ and $|\Delta \vec{r}|$ from equation (i) and (ii) and $t = 2s$, then on solving we get $\alpha = 8$

49 **(c)**

If momentum is Zero ie, if p=0,then kinetic energy

$K = \frac{p^2}{2m} = 0$

But potential energy cannot be zero, thus a body can have energy without momentum.

50 **(c)**

The variation of potential energy(U)

With distance(x)is

$U = \frac{1}{2}kx^2$

Hence, parabolic graph is obtained.
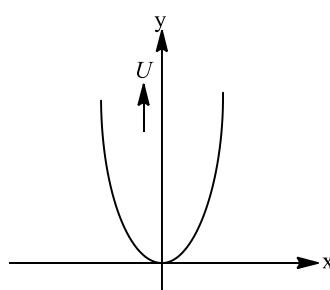
51 **(b)**

Because 50% loss in kinetic energy will affect its potential energy and due to this ball will attain only half of the initial height

52 **(a)**

Effective height through which man moves up

$= 1 - h$

53 **(c)**

Kinetic energy at highest point

$(KE)_H = \frac{1}{2}mv^2 \cos 2\theta$

$= K \cos^2 \theta$

$= K(\cos 60°)^2$

$= \frac{K}{4}$

54 **(b)**

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$\therefore 10 \times u_1 + 5 \times 0 = (10 + 5) \times 4$

Or $u_1 = \frac{15 \times 4}{10} = 6ms^{-1}$

55 **(b)**

$W = \int F dy$

$= \int_{-a}^{+a} (Ay^2 + By + C) dy$

$= \left[\frac{Ay^3}{3} + \frac{By^2}{2} + Cy \right]_{-a}^{+a}$

$= \left[\frac{Aa^3}{3} + \frac{Ba^2}{2} + Ca \right] - \left[-\frac{Aa^3}{3} + \frac{Ba^2}{2} - Ca \right]$

$= \frac{2Aa^3}{3} + 2Ca$

56 **(b)**

Due to theory of relativity

57 **(a)**

Potential energy increases and kinetic energy decreases when the height of the particle increases it is clear from the graph (a)

58 **(a)**

$\frac{1}{2}mv^2 - f_k x = \frac{1}{2}kx^2$

$\frac{1}{2} \times 2 \times 16 - 15x = \frac{1}{2} \times 10^4 \times x^2$

$\therefore x = 5.5 \, cm$

60 **(b)**

Work done is given by

$F \cdot s = (2\hat{\imath} + 4\hat{\jmath}) \cdot (3\hat{\jmath} + 5\hat{k})$

=12j

Now, power=$\frac{work}{time} = \frac{12}{2} = 6w$

62 **(c)**

Useful work $= \frac{75}{100} \times 12 \, J = 9J$

Now, $\frac{1}{2} \times 1 \times v^2 = 9$ or $v = \sqrt{18}ms^{-1}$

63 **(b)**

$a = \frac{10 - 0}{5} ms^{-2} = 2ms^{-2}$;

$F = ma$ or $F = 1000 \times 2 \, N = 2000 \, N$

Average velocity $= \frac{0+10}{2} ms^{-1} = 5ms^{-1}$

Average power $= 2000 \times 5 \, W = 10^4 \, W$

Required horse power is $\frac{10^4}{746}$

64 **(b)**

When target is very light and at rest then after head on elastic collision it moves with double speed of projectile $i.e.$ the velocity of body of

mass m will be $2v$

65 **(d)**

Work done = change in kinetic energy

$W = \frac{1}{2}mv^2$

$\therefore W \propto v^2$ graph will be parabolic in nature

66 **(a)**

Velocity of $50\ kg$ mass after $5\ sec$ of projection

$v = u - gt = 100 - 9.8 \times 5 = 51\ m/s$

At this instant momentum of body is an upward direction

$P_{\text{initial}} = 50 \times 51 = 2550\ kg - m/s$

After breaking $20\ kg$ piece travels upwards with $150\ m/s$ let the speed of $30\ kg$ mass is V

$P_{\text{final}} = 20 \times 150 + 30 \times V$

By the law of conservation of momentum

$P_{\text{initial}} = P_{\text{final}}$

$\Rightarrow 2550 = 20 \times 150 + 30 \times V \Rightarrow V = -15\ m/s$

$i.e.$ it moves in downward direction

67 **(d)**

Mass to be lifted $= 10 \times 10^2 \text{kg}$

[$\because$ density of water $= 10^3 \text{kgm}^{-3}$]

Height, $h = 10$ m

Work done $= 10^4 \times 10 \times 10 = 10^6 \text{J}$

68 **(b)**

By momentum conservation before and after collision

$m_1 V + m_2 \times 0 = (m_1 + m_2)v \Rightarrow v = \frac{m_1}{m_1 + m_2} V$

$i.e.$ Velocity of system is less than V

69 **(b)**

Linear momentum of water striking per second to the wall $P_1 = mv = Av\rho\, v = Av^2\,\rho$, similarly linear momentum of reflected water per second

$P_r = Av^2\rho$
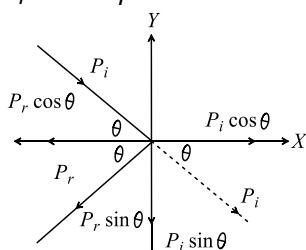
Now making components of momentum along x-axes and y-axes. Change in momentum of water per second

$= P_i \cos\theta + P_r \cos\theta$

$= 2Av^2\,\rho \cos\theta$

By definition of force, force exerted on the Wall $= 2Av^2\,\rho \cos\theta$

70 **(c)**

Initial linear momentum of system $= m_A \vec{v}_A + m_B \vec{v}_B$

$= 0.2 \times 0.3 + 0.4 \times v_B$

Finally both balls come to rest

$\therefore$ final linear momentum $= 0$

By the law of conservation of linear momentum

$0.2 \times 0.3 + 0.4 \times v_B = 0$

$\therefore v_B = -\frac{0.2 \times 0.3}{0.4} = -0.15\ m/s$

71 **(c)**

Let velocity of masses after explosion be v_1 and v_2, then from law of conservation of momentum, we have

Momentum before explosion = Momentum after explosion

$MV = m_1 v_1 + m_2 v_2$

$Given\ m_1 = m_2 = m, v_2 = 0$,

$\therefore Mv = mv_1 + m \times 0$

$\Rightarrow v_1 = \frac{Mv}{m}.$

72 **(c)**

While moving from $(0,0)$ to $(a, 0)$

Along positive x-axis, $y = 0$ $\therefore \vec{F} = -kx\hat{j}$

$i.e.$, force is in negative y- direction while displacement is in positive x-direction

$\therefore W_1 = 0$

Because force is perpendicular to displacement

Then particle moves from $(a, 0)$ to $(a. a)$ along a line parallel to y-axis $(x = +a)$ during this $\vec{F} = -k(y\hat{i} + a\hat{j})$

The first component of force, $-ky\hat{i}$ will not contribute any work because this component is along negative x-direction $(-\hat{i})$ while displacement is in positive y-direction $(a, 0)$ to (a, a). The second component of force $i.e. -ka\hat{j}$ will perform negative work

$\therefore W_2 = (-ka\hat{j})(a\hat{j}) = (-ka)(a) = -ka^2$

So net work done on the particle $W = W_1 + W_2$

$= 0 + (-ka^2) = -ka^2$

73 **(c)**
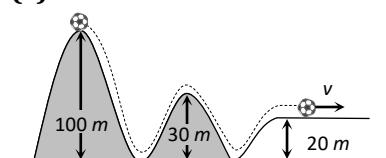
Ball starts from the top of a hill which is $100\ m$ high and finally rolls down to a horizontal base which is $20\ m$ above the ground so from the conservation of energy $mg(h_1 - h_2) = \frac{1}{2}mv^2$

$$\Rightarrow v = \sqrt{2g(h_1 - h_2)} = \sqrt{2 \times 10 \times (100 - 20)}$$
$$= \sqrt{1600} = 40 \, m/s$$

74 **(c)**
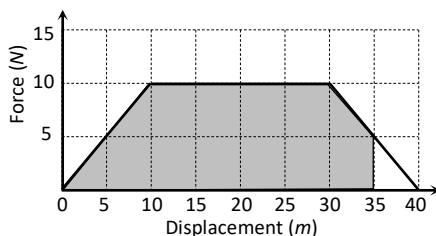
Work done = (Shaded area under the graph between

$x = 0$ to $x = 35 \, m) = 287.5 \, J$

75 **(c)**

Let m_1, m_2 be the masses of first and second fragments respectively and v_1, v_2 be their velocities after explosion.

From conservation of momentum

$Mv = m_1, m_2 + m_2 v_2$

Where, M is mass of bomb before explosion and vits velocity.

Since, bomb is stationary, hence v=0

Given ,$m_1 = 1g = 1 \times 10^{-3} kg = 0.001 kg$

$m_2 = 3g = 3 \times 10^{-3} kg = 0.003$ kg and $E_k = 6.4 \times 10^4$J

$\therefore 0 = m_1 v_1 + m_2 v_2$

$or \qquad 0 = 0.001 v_1 + 0.003 v_2$

Or $\qquad v_2 = -\dfrac{v_1}{3}$ ....(i)

Total kinetic energy is

$$E_K = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$E_k = \frac{1}{2} \times (0.001) v_1^2 + \frac{1}{2} \times (0.003) v_2^2$ ...(ii)

$$\therefore E_k = \frac{1}{2} \times (0.001) v_1^2 + \frac{1}{2} (0.003) \times \left(-\frac{v_1^2}{3}\right)^2$$

$$E_k = \frac{1}{2} \times (0.001) \left(v_1^2 + 3 \times \frac{v_1^2}{9}\right)$$

$E_k = \frac{1}{2} \times (0.001) \times \frac{4 v_1^2}{3} = \frac{(0.002) v_1^2}{3}$ ...(iii)

$$\therefore \qquad 6.4 \times 10^4 = \frac{(0.002) v_1^2}{3}$$

Or $\quad v_1^2 = \frac{3 \times 6.4 \times 10^4}{0.002}$

Or $\quad v_1^2 = \frac{3 \times 6.4 \times 10^4}{0.002}$

$or v_1^2 = 96 \times 10^6 = 9.6 \times 10^7 ms^{-1}$

Hence, kinetic energy of smaller fragment is

$E'_K = \frac{1}{2} m_1 v_1^2$

$E'_k = \frac{1}{2} \times (0.001) \times 9.6 \times 10^7$

$E'_k = 4.8 \times 10^4$J.

76 **(b)**

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 0.1} = \sqrt{1.96} = 1.4 \, m/s$

77 **(c)**

The explanation are given below

(i)If a body is moved up in inclined plane, then the work done against friction force is zero as there is no friction. But a work has to be done against the gravity. So, this statement is incorrect.

(ii)If there were no friction, moving vehicles could not be stopped by locking the brakes. Vehicles are stopped by air friction only.

So , This Statement is correct.

(iii) In this situation the normal reaction is given by
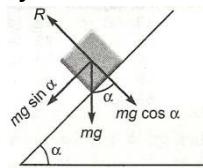
$R = mg \cos \alpha \qquad ... (i)$

Ifα increase then the value of $\cos \alpha$ also decreases. So, this Statement is incorrect.

(iv)When the duster is rubbing upward then an external force is applied and its value is
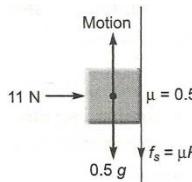
F'=0.5g+μR

$\therefore \quad F' = 0.5g + 0.5 \times 11$

Or $F' = (0.5 \times 10 + 5.5)$N (Here R=11 N)

Or $F' = 10.5$N

Hence, work done in rubbing the duster through a distance of 10 cm.

$W = F' \times d$

$\Rightarrow \qquad W = 10.5 \times \dfrac{10}{100}$J

Or $F' = 10.5$J

78 **(a)**

Initially ^{238}U nucleus was at rest and after decay its part moves in opposite direction
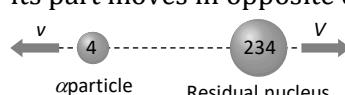
According to conservation of momentum

$4v + 234V = 238 \times 0 \Rightarrow V = -\dfrac{4v}{234}$

79 **(d)**

$W = FS \cos \theta = 10 \times 4 \times \cos 60° = 20 \, Joule$

80 **(d)**

Potential energy $V = \dfrac{x^4}{4} - \dfrac{x^2}{2}$

For maximum kinetic energy, potential energy of a particle should be minimum

For minimum value of V, $\frac{dV}{dx} = 0$ and $\frac{d^2V}{dx^2} > 0$

Force $F = -\left(\frac{dV}{dx}\right) = \frac{4x^3}{4} - \frac{2x}{2} = 0 \Rightarrow x^3 - x = 0$

$\Rightarrow x(x^2 - 1) = 0$

$i.e.$ at $x = 0, x = +1$ and $x = -1$ for on the particle will be zero

Now $\frac{d^2V}{dx^2} = 3x^2 - 1$

For $x = +1$ and $x = -1$ $\frac{d^2V}{dx^2} > 1$

It means the potential energy of the particle will be minimum at $x = 1$ and $x = -1$

Now substituting these values in expression of potential energy

Energy $V_{\min} = \left[\frac{(1)^4}{4} - \frac{(1)^2}{2}\right]J = \left[\frac{1}{4} - \frac{1}{2}\right]J = -\frac{1}{4}J$

(Kinetic energy)$_{\max}$
$$= \text{Total energy}$$
$$- (\text{potential energy})_{\min}$$
$$= 2 - \left(-\frac{1}{4}\right)$$

$\frac{1}{2}mv_{\max}^2 = \frac{9}{4} \Rightarrow v_{\max}^2 = \frac{9}{2} \Rightarrow v_{\max} = \frac{3}{\sqrt{2}} \ m/sec$

81 **(a)**

Work = Force × Displacement (length)

If unit of force and length be increased by four times then the unit of energy will increase by 16 times

82 **(b)**

In elastic head on collision velocities gets interchanged

83 **(d)**

According to law of conservation of energy

$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mgh$

$490 = 245 + 5 \times 9.8 \times h$

$h = \frac{245}{49} = 5m$

84 **(d)**

If there is no air drag then maximum height

$H = \frac{u^2}{2g} = \frac{14 \times 14}{2 \times 9.8} = 10 \ m$

But due to air drag ball reaches up to height $8m$ only. So loss in energy

$= mg(10 - 8) = 0.5 \times 9.8 \times 2 = 9.8 J$

85 **(d)**

Velocity at B when dropped from A

where $AC = s$

$v^2 = u^2 + 2g(s - x)$ ....(i)

$v^2 = 2g(s - x)$ ....(ii)

Potential energy at $B = mgx$

∴ Kinetic energy = 3 × potential energy

$\frac{1}{2}m \times 2g(s - x) = 3 \times mgx$

or $(s - x) = 3x$

or $s = 4x$ or $x = \frac{s}{4}$

From Eq. (i)

$v^2 = 2g(s - x)$

$= 2g\left(s - \frac{s}{4}\right)$

$= \frac{2g \times 3s}{4} = \frac{3gs}{2}$

∴ $x = \frac{s}{4}$ and $v = \sqrt{\frac{3gs}{2}}$

86 **(c)**

Kinetic energy $= \frac{1}{2}mv^2$

As both balls are falling through same height, therefore they possess same velocity.

∴ $\frac{(\text{KE})_1}{(\text{KE})_2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$

87 **(c)**

$100 = \frac{1}{2}kx^2$ [Given]

$W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2}k[(2x)^2 - x^2]$

$= 3 \times \left(\frac{1}{2}kx^2\right) = 3 \times 100 = 300 \ J$

88 **(a)**

Given, m=2kg, v=$20ms^{-1}$, $\theta = 60°$

Power(P)is given as

$P = F \cdot v = Fv\cos\theta$

$P = mgv \ \cos\theta$

∴ $P = 2 \times 20 \times 10 \times \cos 60°$

$P = 2 \times 20 \times 10 \times \frac{1}{2}$

$\Rightarrow \quad P = 200 \ W$

89 **(a)**

Work done = Area covered in between force displacement curve and displacement axis

= Mass ×Area covered in between acceleration-displacement curve and displacement axis

$= 10 \times \frac{1}{2}(8 \times 10^{-2} \times 20 \times 10^{-2}) = 8 \times 10^{-2}J$

90 **(d)**

Before explosion   After explosion
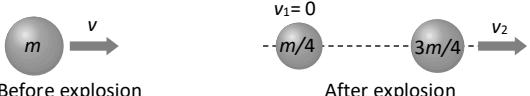
According to conservation of momentum

$$mv = \left(\frac{m}{4}\right)v_1 + \left(\frac{3m}{4}\right)v_2 \Rightarrow \frac{4}{3}\,v$$

91 **(b)**

$P = \sqrt{2mE}$ if E are equal then $P \propto \sqrt{m}$

$i.e.$, heavier body will possess greater momentum

92 **(b)**

$$a_A = \frac{F}{m_A} = \frac{4 \times 10}{20} = 2ms^{-2}$$

$$a_B = \frac{F}{m_B} = \frac{4 \times 10}{5} = 8ms^{-2}$$

Given that, $\quad K_A = K_B$

$i.e.,\qquad \frac{1}{2}m_A v_A^2 = \frac{1}{2}m_B v_B^2$

Or $\quad m_A(u + a_A t_A)^2 = m_B(u + a_B t_B)^2 \qquad (\because v = u + at)$

Or $m_A a_A^2 t_A^2 = m_B a_B^2 t_B^2 \quad (\because u = 0)$

Or $\qquad \frac{t_A}{t_B} = \sqrt{\frac{m_B}{m_A} \times \frac{a_B^2}{a_A^2}}$

$$= \sqrt{\frac{5}{20} \times \frac{(8)^2}{(2)^2}} = \sqrt{\frac{5 \times 64}{20 \times 4}} = 2$$

93 **(b)**

The linear momentum of exploding part will remain conserved.

Applying conservation of linear momentum, We write,

$m_1 u_1 = m_2 u_2$

Here, $m_1 = 18$kg, $m_2 = 12$kg

$u_1 = 6ms^{-1}, u_2 =?$

$\therefore 18 \times 6 = 12\,u_2$

$\Rightarrow u_2 = \frac{18 \times 6}{12}\quad 9ms^{-1}$

Thus, kinetic energy of 12 kg mass

$k_2 = \frac{1}{2}m_2 u_2^2$

$= \frac{1}{2} \times 12 \times (9)^2$

$= 6 \times 81$

$= 486$ J

94 **(c)**

$P = \sqrt{2mE}$ it is clear that $P \propto \sqrt{E}$

So the graph between P and $\sqrt{E}$ will be straight line

But graph between $\frac{1}{P}$ and $\sqrt{E}$ will be hyperbola

95 **(d)**
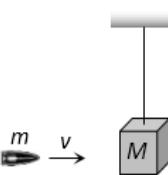
Initial momentum $= mv$

Final momentum $= (m + M)V$

By conservation of momentum $mv = (m + M)V$

$\therefore$ Velocity of (bag + bullet) system $V = \frac{mv}{M+m}$

$\therefore$ Kinetic energy $= \frac{1}{2}(m + M)V^2$

$$= \frac{1}{2}(m + M)\left(\frac{mv}{M+m}\right)^2 = \frac{1}{2}\frac{m^2 v^2}{M+m}$$

96 **(b)**

Here $k = \frac{1}{2}mv^2 = as^2$

$\therefore mv^2 = 2as^2$

Differentiating w.r.t. time t

$$2mv\frac{dv}{dt} = 4as\frac{ds}{dt} = 4asv, m\frac{dv}{dt} = 2as$$

This is the tangential force, $F_t = 2as$

Centripetal force $F_c = \frac{mv^2}{R} = \frac{2as^2}{R}$

$\therefore$ Force acting on the particle

$$F = \sqrt{F_t^2 + F_c^2} = \sqrt{(2as)^2 + \left(\frac{2as}{R}\right)^2}$$

$$= 2as\sqrt{1 + s^2/R^2}$$

97 **(c)**

The relation between linear momentum and kinetic energy is

$p^2 = 2mk \qquad ....(i)$

But linear momentum is increased by 50%, then

$p' = \frac{150}{100}p$

$p' = \frac{3}{2}p$

Hence, $p'^2 = 2mk'$

Or $\qquad \left(\frac{3}{2}p\right)^2 = 2mk'$

Or $\qquad \frac{9}{4}p^2 = 2mk' \qquad ....(ii)$

On putting the value of p^2 from Eq. (i) in Eq. (ii)

$\frac{9}{4} \times 2mk = 2mk'$

Or $K' = \frac{9}{4}k$

So, the increase in kinetic energy is

$\Delta K = \frac{9}{4}k - k = \frac{5}{4}k$

Hence, percent increase in kinetic energy

$= \frac{(5/4)K}{K} \times 100\%$

$= \frac{5}{4} \times 100\% = 125\%$

98 (c)

Mass of the shell $= m_1 = 0.2\ kg$

Mass of the gun $= m_2 = 4kg$

Let energy of shell $= E_1$, energy of gun $= E_2$

Total energy liberated

$= E_1 + E_2 = 1050\ Joule$ ...(i)

As $E = \frac{P^2}{2m}$

$\therefore \frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{4}{0.2} = 20 \Rightarrow E_2 = \frac{E_1}{20}$ ...(ii)

From equation (i) and (ii) we get $E_1 = 1000\ Joule$

$\therefore$ Kinetic energy of the shell $= \frac{1}{2} m_1 v_1^2 = 1000$

$\Rightarrow \frac{1}{2}(0.2)v_1^2 = 1000 \Rightarrow v_1 = \sqrt{10000} = 100\ m/s$

99 (c)

From energy conservation,

$\frac{1}{2}kx^2 = \frac{1}{2}(4k)y^2$

$\frac{y}{x} = \frac{1}{2}$

100 (d)

KE of colliding body before collision $= \frac{1}{2}mv^2$

After collision its velocity becomes

$V' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v = \frac{m}{3m}v = \frac{v}{3}$

KE after collision $= \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{v}{3}\right)^2$

$= \frac{1}{2}\frac{mv^2}{9}$

Ratio of kinetic energy $= \frac{KE_{before}}{KE_{after}}$

$= \frac{\frac{1}{2}mv^2}{\frac{1}{2}\frac{mv^2}{9}} = \frac{9}{1}$

101 (b)

Initial condition   Final condition
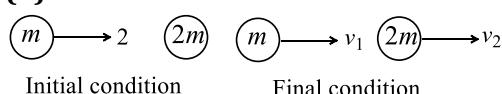
By conservation of linear momentum

$2m = mv_1 + 2mv_2 \Rightarrow v_1 + 2v_2 = 2$

By definition of $e, e = \frac{1}{2} = \frac{v_2 - v_1}{2 - 0}$

$\Rightarrow v_2 - v_1 = 1 \Rightarrow v_1 = 0$ and $v_2 = 1ms^{-1}$

102 (c)

According to work-energy theorem

$W =$ Change in kinetic energy

$FS\cos\theta = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Substituting the given values, we get

$20 \times 4 \times \cos\theta = 40 - 0 [\because u = 0]$

$\cos\theta = \frac{40}{80} = \frac{1}{2}$

$\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60°$

103 (a)

Applying principle of conservation of linear momentum, velocity of the system (v) is

$m_1 v_1 = (m_1 + m_2)V, \Rightarrow V = \frac{m_1 v_1}{m_1 + m_2}$

$= \frac{50 \times 10}{(50 + 950)} = \frac{1}{2}\text{ms}^{-1}$

Initial KE, $E_1 = \frac{1}{2}m_1 v_1^2 = \frac{1}{2} \times \left(\frac{50}{1000}\right) \times 10^2 = 2.5$ J

Final KE, $E^2 = \frac{1}{2}(m^1 + m^2)v^2$

$= \frac{1}{2}\frac{(50 + 950)}{1000} \times \frac{1}{2} = 0125$ J

Percentage loss is KE

$\frac{E_1 - E_2}{E_1} \times 100 = \frac{2.5 - 0.125}{2.5} = 95\%$

104 (c)

Initially potential energy $= \frac{1}{2}kx^2$

$\Rightarrow U = \frac{1}{2}kx^2$

or $2U = kx^2 \Rightarrow k = \frac{2U}{x^2}$

When it is stretched to nx cm, then

PE $= \frac{1}{2}kx_1^2 = \frac{1}{2} \times \frac{2U}{x^2} \times n^2 x^2 = n^2 U$

$\therefore$ Potential energy stored in the spring $= n^2 U$

105 (b)

The angle between the displacement and the applied retarded force is 180^0

$\therefore$ Work done $= Fs\cos 180° - Fs$

$= -$Ve

107 (b)

$W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2} \times 800 \times (15^2 - 5^2) \times 10^{-4}$

$= 8J$

108 (b)

Let M be the mass of body moving with velocity v and m be mass of each broken part, velocity of one part which retraces back is v and that of second part is v'.

Momentum before breaking $=$ momentum after breaking

$Mv = m(-v) + mv'$

Or $v' = \frac{Mv + mv}{m}$

Since, M$=$2m, therefore

$v' = \frac{(2m + m)v}{m} = 3v$

109 (b)

$E = \frac{P^2}{2m} \therefore E \propto \frac{1}{m}$ [If $P =$ constant]

$i.\,e.$, the lightest particle will possess maximum kinetic energy and in the given option mass of electron is minimum

110 (c)
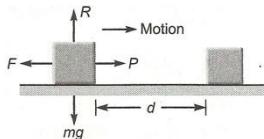
As shown a block of mass M is lying over rough horizontal surface. Let μ be the coeefficient of kinetic friction between the two surfaces in contact. The force Of friction between the block and horizontal surface is given by

$F = \mu R = \mu M g \qquad (\because R = Mg)$

To move the block without acceleration, the force (P) required will be just equal to the force of friction , ie ,

$P = F = \mu R$

If d is the distance moved , then work done is given by

$W = P \times d = \mu R d$

111 (a)

Momentum would be maximum when KE would be maximum and this is the case when total elastic PE is converted KE.

According to conservation of energy

$\frac{1}{2} k L^2 = \frac{1}{2} M v^2$

Or $kL^2 = \frac{(Mv)^2}{M}$

$MKL^2 = p^2 (p = Mv)$

$\therefore p = L\sqrt{MK}$

112 (d)

In compression or extension of a spring work is done against restoring force

In moving a body against gravity work is done against gravitational force of attraction

It means in all three cases potential energy of the system increases

But when the bubble rises in the direction of upthrust force then system works so the potential energy of the system decreases

113 (b)

According to question, $\frac{1}{2} m_A v_A^2 = \frac{1}{2} m_B v_B^2$

$\Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{m_B}{m_A}} = \sqrt{\frac{5}{20}} = \frac{1}{2}$

Using Impulse Momentum

$\frac{F \Delta t_A}{F \Delta t_B} = \frac{m_A \Delta v_A}{m_B \Delta v_B} \Rightarrow \frac{\Delta t_A}{\Delta t_B} = \frac{20}{5} \times \frac{1}{2} = 2$

114 (d)

$P = \sqrt{2ME}$. If kinetic energy are equal then $P \propto \sqrt{m}$

i.e., heavier body posses large momentum

As $M_1 < M_2$ therefore $M_1 V_1 < M_2 V_2$

115 (b)

Given $W = 25$ J, $F = 5$ N, $\Delta s = 10$m

Work=Force× displacement

$W = (F \cos \theta) \times \Delta s$

Or $\qquad \cos \theta = \frac{W}{F \cdot \Delta s}$

Or $\cos \theta = \frac{25}{5 \times 10} = \frac{1}{2}$ or $\theta = \cos^{-1}\left(\frac{1}{2}\right) = 60°$

Hence, angle between force and direction of body is 60°.

116 (a)

Momentum conservation

$5 \times 10 + 20 \times 0 = 5 \times 0 + 20 \times v \Rightarrow v = 2.5 \, m/s$

117 (c)

$W = \Delta K$ or $W_T + W_g + W_F = 0$

(Since, change in kinetic energy is zero)
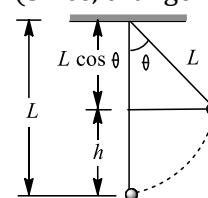
Here, W_T = work done by tension = 0

W_g = work done by fore of gravity

$= -mgh$

$= -mgL(1 - \cos \theta)$

$\therefore W_F = -W_g = mgL(1 - \cos \theta)$

119 (b)

When ball falls vertically downward from height h_1 its velocity $\vec{v}_1 = \sqrt{2gh_1}$

And its velocity after collision $\vec{v}_2 = \sqrt{2gh_2}$

Change in momentum

$\Delta \vec{P} = m(\vec{v}_2 - \vec{v}_1) = m(\sqrt{2gh_1} + \sqrt{2gh_2})$

[Because $\vec{v}_1$ and $\vec{v}_2$ are opposite in direction]

121 (d)

Initially mass 10 gm moves with velocity 100 cm/s

$\therefore$ Initial momentum $= 10 \times 100 = 1000 \frac{gm \times cm}{sec}$

After collision system moves with velocity v_{sys}. then

Final momentum $= (10 + 10) \times v_{sys.}$

By applying in conservation of momentum

$1000 = 20 \times v_{sys.}$

$\Rightarrow v_{sys.} = 50 \, cm/s$

If system rises upto height h then

$h = \frac{v_{sys}^2}{2g} = \frac{50 \times 50}{2 \times 1000} = \frac{2.5}{2} = 1.25 \, cm$

122 (c)

Opposing force in vertical pulling $= mg$

But opposing force on an inclined plane is $mg \sin \theta$, which is less than mg

123 (b)

Work done, $W = F \cdot ds = (F_1 + F_2) \cdot (s_2 - s_1)$

$= \{(4\hat{i} + \hat{j} - 3\hat{k}) + (3\hat{i} + \hat{j} - \hat{k})\}$
$\{(5\hat{i} + 4\hat{j} + \hat{k}) - (\hat{i} + 2\hat{j} + 3\hat{k})\}$

$= (7\hat{i} + 2\hat{j} - 4\hat{k}) \cdot (4\hat{i} + 2\hat{j} - 2\hat{k})$

$= 28 + 4 + 8 = 40 \text{ J}$

124 (d)

$$P = \frac{mgh}{t}$$

$$m = \frac{Pt}{gh} = \frac{200 \times 60}{10 \times 10} = 1200 \text{ L}$$

126 (a)

By conservation of momentum, $mv + M \times 0 = (m + M)V$

Velocity of composite block $V = \left(\frac{m}{m+M}\right)v$

K.E. of composite block $= \frac{1}{2}(M + m)V^2$

$= \frac{1}{2}(M + m)\left(\frac{m}{M+m}\right)^2 v^2 = \frac{1}{2}mv^2\left(\frac{m}{m+M}\right)$

127 (c)

$$\frac{1}{2}m_1 u_1^2 - \frac{1}{2}m_1 v_1^2 = \frac{75}{100} \times \frac{1}{2}m_1 u_1^2$$

Or $\quad u_1^2 - v_1^2 = \frac{3}{4}u_1^2$

or $\quad v_1 = \frac{1}{2}u_1 \quad$ ....(i)

Now $\quad v_1 = \frac{(m_2 - m_1)u_1}{(m_1 + m_2)} \quad$ .... (ii)

Thus, $\quad \frac{1}{2}u_1 = \frac{(m_2 - m_1)u_1}{(m_1 + m_2)}$

or $\quad m_2 = 3m_1 = 3m$

128 (d)

Kinetic energy of ball=potential energy of spring

i.e., $\quad B \quad \frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\therefore \quad 16 \times 10^{-3} \times v^2 = \frac{90}{10^{-2}} \times (12 \times 10^{-2})^2$

Or $v^2 = \frac{90 \times 144 \times 10^{-4}}{10^{-2} \times 16 \times 10^{-3}}$

Or $v = 90 ms^{-1}$

129 (b)

Kinetic energy, $K = \frac{P^2}{2m}$

Where P is the momentum and m is the mass. When momentum is increased by 20%, then

$$\rho' = P + \frac{20}{100}P = 1.2P$$

$\therefore K' = \frac{(1.2P)^2}{2m} = \frac{1.44P^2}{2m} = 1.44K$

$K' = K + 0.44K \Rightarrow \frac{K' - K}{K} = 0.44$

Percentage increase in kinetic energy is

$$\frac{K' - K}{K} \times 100 = 0.44 \times 100 = 44\%$$

130 (a)
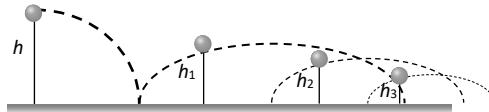
Particle falls from height h then formula for height covered by it in nth rebound is given by

$$h_n = he^{2n}$$

Where e = coefficient of restitution, n = No. of rebound

Total distance travelled by particle before rebounding has stopped

$H = h + 2h_1 + 2h_2 + 2h_3 + 2h_4 + \cdots$

$= h + 2he^2 + 2he^4 + 2he^6 + 2he^8 + \cdots$

$= h + 2h(e^2 + e^4 + e^6 + e^8 + \cdots)$

$= h + 2h\left[\frac{E^2}{1 - e^2}\right] = h\left[1 + \frac{2e^2}{1 - e^2}\right] = h\left(\frac{1 + e^2}{1 - e^2}\right)$

131 (d)

If it is a completely inelastic collision then

$m_1 v_1 + m_2 v_2 = m_1 v + m_2 v$

$v = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} \quad \overset{m_1}{\underset{v_1}{\rightarrow}} \quad \overset{m_2}{\underset{v_2}{\rightarrow}}$

$$KE = \frac{p_1^2}{2m_1} + \frac{p_2^2}{2m_2}$$

As p_1 and p_2 both simultaneously cannot be zero therefore total KE cannot lost.

132 (d)

$h_n = he^{2n}$, if $n = 2$ then $h_2 = he^4$

133 (d)

Slope of inclined plane, $\sin \theta = 1/100$

Component o weight down the inclined plane

$F = mg \sin \theta = 100 \times 9.8 \times 1/100 = 9.8 \text{ N}$

s = distance moved = 10 m

$W = F s = 9.8 \times 10 = 98 \text{ J}$

134 (a)

If after the collision of two bodies, the total kinetic energy of the bodies remains the same as it was before the collision, and also momentum remains same, then it is a case of perfectly elastic collision.

Momentum before collision= Momentum after collision

Kinetic energy before collision

=Kinetic energy after collision

Also, $u_1 - u_2 = -(v_1 - v_2)$

Where $(u_1 - u_2)$ is the relative velocity before the collision and $(v_1 - v_2)$ is the relative velocity after the collision. Thus, in a perfectly elastic collision the relative velocity remains unchanged in magnitude, but is reserved in direction. Hence,

velocity of the last ball is $-0.4\ ms^{-1}$.

135 (a)

$P = (mg\sin\theta + F)v$

$= \left(1000 \times 10 \times \dfrac{1}{20} + 200\right) \times 20$

$= 1400\ \text{W} = 14\ \text{kW}$

136 (b)

$k_A > k_B, x$ is the same

$\therefore \dfrac{1}{2}k_A x^2 > \dfrac{1}{2}k_B x^2 \Rightarrow W_A > W_B$

Forces are the same

$k_A x_A = k_B x_B, \text{As}\ k_A > k_B,\ x_A < x_B$

$W_A' = \dfrac{1}{2}(k_A x_A)x_A$ and $W_B' = \dfrac{1}{2}(k_B x_B)x_B$

$\therefore W_A' < W_B'; \therefore W_A > W_B$ but $W_A' < W_B'$

137 (a)

$K = \dfrac{1}{2}mv^2$

$\dfrac{dK}{dt} = mv.\dfrac{dv}{dt}$

$= \left(m\dfrac{dv}{dt}\right)v = (ma\ v = 4v)$

As $m = 2$ kg and $a = 2$ ms^{-2}

138 (b)

Potential energy=Kinetic energy

Ie, $\qquad mgh = \dfrac{1}{2}mv^2$

Or $\qquad v = \sqrt{2gh}$

If h_1 and h_2 are initial and final heights, then

$v_1 = \sqrt{2gh_1},\ \ v_2 = \sqrt{2gh_2}$

Loss in velocity

$\Delta v = v_1 - v_2 = \sqrt{2gh_1} - \sqrt{2gh_2}$

$\therefore$Fractional loss in velocity $=\dfrac{\Delta v}{v_1}$

$= \dfrac{\sqrt{2gh_1} - \sqrt{2gh_2}}{\sqrt{2gh_1}}$

$\dfrac{\Delta v}{v_1} = 1 - \sqrt{\dfrac{h_2}{h_1}}$

$= 1 - \sqrt{\dfrac{1.8}{5}}$

$= 1 - \sqrt{0.36} = 1 - 0.6 = 0.4 = \dfrac{2}{5}$

139 (b)

$\Delta U = mgh = 0.2 \times 10 \times 200 = 400J$

$\therefore$ Gain in K.E. = decrease in P.E. = 400 J

140 (c)

Potential energy of a body = 75% of 12 J

$mgh = 9\ J \Rightarrow h = \dfrac{9}{1 \times 10} = 0.9\ m$

Now when this mass allow to fall then it acquire velocity

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.9} = \sqrt{18}\ m/s$

141 (c)

Loss of kinetic energy $=\dfrac{1}{2}\dfrac{m_1 m_2}{m_1+m_2}(v_1 - v_2)^2$

$= \dfrac{1}{2} \times \dfrac{M \times M}{M + M}(V_1 - V_2)^2$

$= \dfrac{M \cdot M}{2(2M)}(V_1 - V_2)^2$

$=\dfrac{M}{4}(V_1 - V_2)$

142 (a)

This is the case of work done by a variable force

$W = \displaystyle\int_0^5 (3x^2 - 2x + 7)dx$

$W = |x^3 + x^2 + 7x|_0^5$

or $W = (5 \times 5 \times 5 - 5 \times 5 + 7 \times 5)$

or $W = (125 - 25 + 35) = 135$ J

143 (a)

$E = \dfrac{p^2}{2m}$. If $P = $ constant then $E \propto \dfrac{1}{m}$

$i.e.$, kinetic energy of heavier body will be less. As the mass of gun is more than bullet therefore it possess less kinetic energy

145 (d)

Let m be the mass of the block, h the height from which it is dropped, and x the compression o the spring. Since, energy is conserved, so

Final gravitational potential energy
= final spring potential energy

or $mg(h + x) = \dfrac{1}{2}kx^2$

or $mg(h + x) + \dfrac{1}{2}kx^2 = 0$

or $kx^2 - 2mg(h + x) = 0$

$kx^2 - 2mgx - 2mgh = 0$

This is a quadratic equation for x. Its solution is

$x = \dfrac{mg \pm \sqrt{(mg)^2 + 2mghk}}{k}$

Now, $mg = 2 \times 9.8 = 19.6$ N

and $hk = 0.40 \times 1960 = 784$ N

$\therefore \quad x = \dfrac{19.6 \pm \sqrt{(19.6)^2 + 2(19.6)(784)}}{1960}$

$= 0.10$ m or -0.080 m

Since, x must be positive (a compression) we accept the positive solution and reject the negative solution. Hence, $x = 0.10$ m

146 (b)

If a body falls from height h, then from equation of motion we know that it will hit the ground with a velocity say u=$\sqrt{2gh}$ which is also the velocity of approach here. Now, if after collision it gains a height h_1 then again by equation of motion $v =$

$\sqrt{2gh}$, which is also the velocity of separation .so, by definition of e,

$$e = \sqrt{\frac{2gh_1}{2gh}} \text{ or } h_1 = e^2 h$$

Given , h=20 m, e=0.9

∴ height attained after first bounce

$h_1 = (0.9)^2 \times 20$

$= 0.9 \times 0.9 \times 20$

$= 16.2$

147 (a)

Kinetic energy, $= \frac{1}{2} \times 950 \times \left(100 \times \frac{5}{18}\right)^2$ J

$= 0.3665 \times 10^6$ J $= 0.367$ MJ

148 (c)

$m_1 v_1 - m_2 v_2 = (m_1 + m_2)v$

$\Rightarrow 2 \times 3 - 1 \times 4 = (2 + 1)v$

$\Rightarrow v = \frac{2}{3}$ m/s

149 (c)

$$U = \frac{1}{2}K(x_2^2 - x_1^2) \Rightarrow U = \frac{1}{2}K(3^2 - 0) \Rightarrow U = 4.5\,K$$

150 (c)

$$E_1 = \frac{1}{2}mv^2$$

$$E_2 = \frac{1}{2}m(v + 1)^2$$

$$\frac{(E_2 - E_1)}{E_1} = \frac{\frac{1}{2}m[(v+1)^2 - v^2]}{\frac{1}{2}mv^2} = \frac{44}{100}$$

On solving, we get $v = 5\text{ms}^{-1}$

152 (d)

For first ball, $mgh_1 = \frac{1}{2}mu^2$
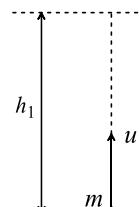
i.e., $h_1 = \frac{u^2}{2g}$

For second ball

$$mgh_2 = mg\frac{u^2 \cos^2 \theta}{2g} = \frac{1}{2}mu^2 \cos^2 \theta$$

$$= \frac{1}{2}mu^2 \cos^2 60°$$

$$= \frac{1}{2}mu^2 \left(\frac{1}{2}\right)^2 = \frac{1}{2}mu^2 \left(\frac{1}{4}\right)$$
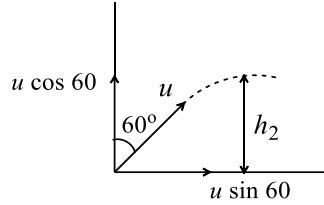
$$\Rightarrow h_2 = \frac{u^2}{8g}$$

$$\therefore \frac{h_1}{h_2} = \frac{u^2}{2g} \times \frac{8g}{u^2} \Rightarrow \frac{h_1}{h_2} = \frac{4}{1}$$

153 (a)

Let initial kinetic energy, $E_1 = E$

Final kinetic energy, $E_2 = E + 300\%$ of $E = 4E$

As $P \propto \sqrt{E} \Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow P_2 = 2P_1$

$\Rightarrow P_2 = P_1 + 100\%$ of P_1

i.e., Momentum will increase by 100%

154 (a)

Let ball is projected vertically downward with velocity v from height h

Total energy at point $A = \frac{1}{2}mv^2 + mgh$

During collision loss of energy is 50% and the ball rises up to same height. It means it possess only potential energy at same level
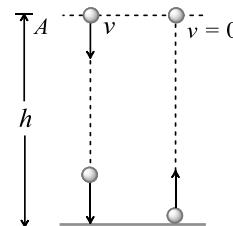
$$50\%\left(\frac{1}{2}mv^2 + mgh\right) = mgh$$

$$\frac{1}{2}\left(\frac{1}{2}mv^2 + mgh\right) = mgh$$

$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20}$$

$$\therefore v = 20\ m/s$$

155 (a)

Power $= 7500$, W $= 7500$ Js^{-1}, velocity$v = 20$ ms^{-1}

$P = Fv$ or $F = \frac{P}{v} = \frac{7500 \text{ Js}^{-1}}{20 \text{ ms}^{-1}} = 375$ N

156 (a)

If a body has momentum, it must have kinetic energy also, (a) is the wrong statement

If the energy is totally potential, it need not have momentum (b) is correct (c) and (d) are also correct

158 (b)

Potential energy at the required height

$= \frac{490}{2} = 245$ J

Again, $245 = 2 \times 10 \times h$ or $h = \frac{245}{20}$ m $= 12.25$ m

159 (c)

The energy gained by the particle

$$U = \frac{1}{2}k(x_2^2 - x_1^2)$$

$$= \frac{1}{2}k(3^2 - 0^2) = \frac{9}{2}k 4.5k$$

160 (b)

Kinetic energy acquired by the body

= Force applied on it × distance covered by the body

K.E. $= F \times d$

If F and d both are same then K. E. acquired by the body will be same

161 (b)

In case of elastic collision ,coefficient of restitution e=1

or

Relative speed of approach =relative speed of separation.

∴ Option (b)is correct.

162 (a)

$$v = \frac{dx}{dt} = 3 - 8t + 3t^2$$

∴ $v_0 = 3\ m/s$ and $v_4 = 19\ m/s$

$W = \frac{1}{2}m(v_4^2 - v_0^2)$ [According to work energy theorem]

$$= \frac{1}{2} \times 0.03 \times (19^2 - 3^2) = 5.28\ J$$

163 (c)

When the ball is released from the top of tower then ratio of distances covered by the ball in first, second and third second

$h_I : h_{II} : h_{III} = 1 : 3 : 5 :$ [Because $h_n \propto (2n - 1)$]

∴ Ratio of work done $mgh_I : mgh_{II} : mgh_{III} = 1 : 3 : 5$

164 (b)

Work done $W = \int_{x_0}^{x_1} F \cdot dx$

$$= \int_0^{x_1} kx\ dx$$

$$= k\left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2}kx_1^2$$

165 (c)
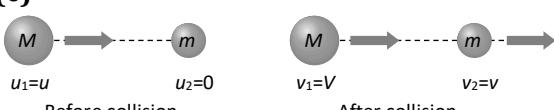
$$v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1 u_1}{m_1 + m_2} = \frac{2mu}{M + m} = \frac{2u}{1 + \frac{m}{M}}$$

167 (b)

$W = mg \sin \theta \times s$

$= 2 \times 10^3 \times \sin 15° \times 10$

$= 5.17\ kJ$

168 (c)

Work done on the wire to strain it will be stored as energy which is converted to heat. Therefore the temperature increases

169 (c)

Force = Rate of change of momentum

Initial momentum $\vec{P}_1 = mv \sin \theta\ \hat{\imath} + mv \cos \theta\ \hat{\jmath}$

Final momentum $\vec{P}_2 = -mv \sin \theta\ \hat{\imath} + mv \cos \theta\ \hat{\jmath}$

$$\therefore \vec{F} = \frac{\Delta \vec{P}}{\Delta t} = \frac{-2mv \sin \theta}{2 \times 10^{-3}}$$

Substituting $m = 0.1\ kg, v = 5\ m/s, \theta = 60°$

Force on the ball $\vec{F} = -250\sqrt{3}N$

Negative sign indicates direction of the force

170 (c)

After impact the mass and block move together and come to rest after a distance of $40\ m$

By conservation of momentum,

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

$0.02 \times 250 + 0.23 \times 0 = 0.02v + 0.23v$

$5 + 0 = v(0.25)$
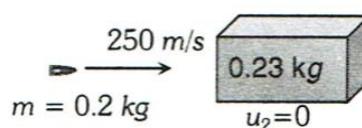
$$\frac{500}{25} = v = 20 ms^{-1}$$

Now, by conservation of energy,

$$\frac{1}{2}Mv^2 = \mu R. d$$

$$\frac{1}{2} \times 0.25 \times 400 = \mu \times 0.25 \times 9.8 \times 40 \Rightarrow \mu = 0.51$$

171 (c)

$$P = \frac{mgh}{t} = 10 \times 10^3 \Rightarrow t = \frac{200 \times 40 \times 10}{10 \times 10^3}$$

$$= 8\ sec$$

172 (c)

According to law of conservation of momentum

Momentum of neutron = Momentum of combination

$\Rightarrow 1.67 \times 10^{-27} \times 10^8$

$= (1.67 \times 10^{-27} + 3.34 \times 10^{-27})v$

∴ $v = 3.33 \times 10^7\ m/s$

173 (c)

Kinetic energy $= \frac{1}{2}mv^2$

As both balls are falling through same height therefore the possess same velocity

But $KE \propto m$ [If $v = $ constant]

$$\therefore \frac{(KE)_1}{(KE)_2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$$

174 **(b)**

Power ,p$= \frac{\text{Total Energy}}{t} = \frac{\text{mgh}+\frac{1}{2}\text{mv}^2}{\text{t}}$

$$\frac{10 \times 10 \times 20 + \frac{1}{2} + 10 \times 10 \times 10}{1}$$

=2000+500=2500 W=2.5 KW

175 **(b)**

From force diagram as shown in figure

$mg - T = ma$
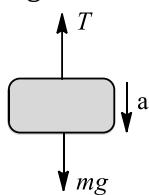
$$T = mg - ma = mg - \frac{mg}{4} = \frac{3mg}{4}$$

$\therefore W_T = $ work done by tension

$$= \vec{T}.\vec{s} = Ts \cos 180° = -\frac{3mgd}{4}$$

176 **(d)**

From conservation of momentum.

Momentum before collision =Momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$20 \times 6 + 30 \times 0 = 20v + 30v$

$\therefore 20 \times 6 = 50v$

Or $v = \frac{120}{50} = 2.4 ms^{-1}$

177 **(a)**

Given that, $S = \frac{1}{3}t^2$

$$v = \frac{dS}{dt} = \frac{2}{3}t; \quad a = \frac{d^2S}{dt^2} = \frac{2}{3}$$

$F = ma = 3 \times \frac{2}{3} = 2N; \quad$ Work $= 2 \times \frac{1}{3}t^2$

At $t=2$

Work $= 2 \times \frac{1}{3} \times 2 \times 2 = \frac{8}{3}$J

178 **(a)**

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 = mv^2$$

$$x = \sqrt{\frac{2mv^2}{k}}$$

180 **(b)**

Work done$=\frac{mgh}{2}$

$$\therefore \quad 100 = \frac{10 \times 10 \times h}{2}$$
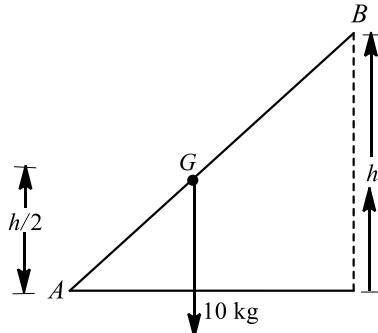
Or $\quad h = 2.0m$

181 **(a)**

Given,$r_1 = 2\hat{\imath} - 3\hat{\jmath} - 4\hat{k}$

And $\quad r_2 = 3\hat{\imath} - 4\hat{\jmath} + 5\hat{k}$

Now, $r_2 - r_1 = \hat{\imath} - \hat{\jmath} + 9\hat{k}$

And $\quad F = 4\hat{\imath} + \hat{\jmath} + 6\hat{k}$

$\therefore \quad$ work done $= F.r$

$W = (4\hat{\imath} + \hat{\jmath} + 6\hat{k}).(\hat{\imath} - \hat{\jmath} + 9\hat{k})$

$\quad = 4 - 1 + 54 = 57$ J

182 **(a)**

Work done = area between the graph and position axis

$W = 10 \times 1 + 20 \times 1 - 20 \times 1 + 10 \times 1 = 20 \, erg$

183 **(d)**

All the central forces are conservative

184 **(d)**

Elastic force in string is conservative in nature

$W = -\Delta V_1$ where $W = $ work done by elastic force of string

$W = -(V_f - V_i) = V_i - V_f$ or $W = \frac{1}{2}kx^2 - \frac{1}{2}k(x+y)^2$

or $W = \frac{1}{2}kx^2 - \frac{1}{2}k(x^2 + y^2 + 2xy)$

$$= \frac{1}{2}kx^2 - \frac{1}{2}kx^2 - \frac{1}{2}ky^2 - \frac{1}{2}k(2xy)$$

$$= -kxy - \frac{1}{2}ky^2$$

$$= \frac{1}{2}ky(-2x - y)$$

The work done against elastic force is

$$W_{\text{ext}} = -W = \frac{ky}{2}(2x + y)$$

185 **(b)**
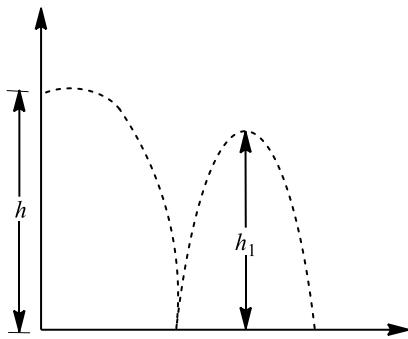
Total distance travelled by the ball before its second hit is

$H = h + 2h_1$

$= h[1 + 2e^2]$ $(\because h_1 = he^2)$

186 (a)

The ratio of masses=1:3

Therefore ,$m_1 = x\,kg, m_2 = 3x\ kg$

Applying law of conservation of momentum

$m_1 v_1 + m_2 v_2 = 0$

$\Rightarrow \quad x \times v_1 + 3x \times 4 = 0$

Or $\quad\quad v_1 = -12 ms^{-1}$

Therefore, velocity of lighter mass is opposite to that of heavier mass.

187 (c)

$$W = \frac{1}{2}k(x_2^2 - x_1^2)$$

$$= \frac{1}{2} \times 5 \times 10^3 (10^2 - 5^2) \times 10^{-4}$$

$$= 18.75\,J$$

188 (d)

By the conservation of momentum

$40 \times 10 + (40) \times (-7) = 80 \times v$

$\Rightarrow v = 1.5\ m/s$

189 (c)
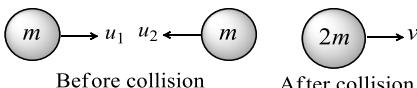
Here, $m = 0.25\ kg, u_1 = 3ms^{-1}, u_2 = -1ms^{-1}$

It is an inelastic collision

According to conservation of momentum

$mu_1 + mu_2 = (m + m)v$

$\Rightarrow v = \dfrac{mu_1 + mu_2}{2m} = \dfrac{u_1 + u_2}{2} = \dfrac{3-1}{2} = 1ms^{-1}$

190 (a)

KE left, $\frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{1}{2}mu^2\right)$

$\therefore$ velocity left, $v = \dfrac{u}{\sqrt{2}} = \dfrac{10^4}{\sqrt{2}} = 7071.06\ ms^{-1}$

191 (c)

From the law of conservation of momentum

$3 \times 16 + 6 \times v = 9 \times 0$

Or $\quad v = -8\ ms^{-1}$

$\Rightarrow \quad\quad\quad v = 8ms^{-1}$(numerically)

Therefore, its kinetic energy

$$k = \frac{1}{2} \times 6 \times (8)^2 = 192J$$

192 (d)

Change in momentum $= m\vec{v}_2 - m\vec{v}_1 = -mv - mv = -2mv$

193 (b)

Work done=area enclosed by $F - x$graph

=area of $ABNM$ + area of CDEN - area of $EFGH$ + area of HIJ
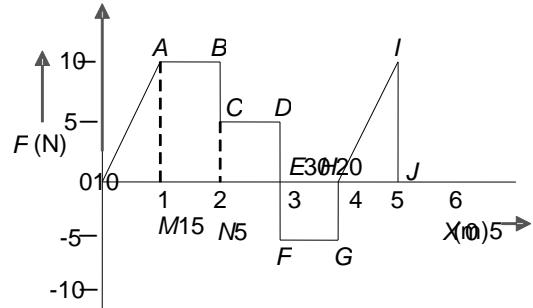
$= 1 \times 10 + 1 \times 5 - 1 \times 5 + \frac{1}{2} \times 1 \times 10$

$= 10 + 5 - 5 + 5 = 15\ J$

194 (d)

Using conservation of linear momentum, we have

$mv_0 = mv + 2mv$

Or $\quad v = \dfrac{v_0}{3}$

Using conservation of energy, we have

$$\frac{1}{2}mv_0^2 = \frac{1}{2}kx_0^2 + \frac{1}{2}(3m)v^2$$

Where x_0=compression in the spring ,

$\therefore mv_0^2 = kx_0^2 + (3m)\dfrac{v_0^2}{9}$

Or $\quad kx_0^2 = mv_0^2 - \dfrac{mv_0^2}{3}$

Or $kx_0^2 = \dfrac{2mv_0^2}{3}$

$\therefore k = \dfrac{2mv_0^2}{3x_0^2}$

195 (b)
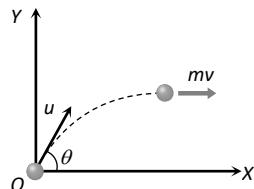
Momentum of ball (mass m) before explosion at the highest point $= mv\hat{i} = mu\cos 60\,°\hat{i}$

$= m \times 200 \times \dfrac{1}{2}\hat{i} = 100\ m\hat{i}\ kgms^{-1}$
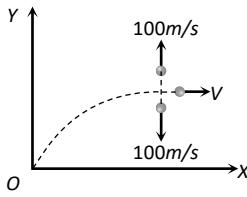
Let the velocity of third part after explosion is V

After explosion momentum of system $= \vec{P_1} + \vec{P_2} + \vec{P_3}$

$= \frac{m}{3} \times 100\hat{j} - \frac{m}{3} \times 100\hat{j} + \frac{m}{3} \times V\hat{i}$

By comparing momentum of system before and after the explosion

$\frac{m}{3} \times 100\hat{j} - \frac{m}{3} \times 100\hat{j} + \frac{m}{3}V\hat{i} = 100m\hat{i} \Rightarrow V$
$= 300 m/s$

196 (b)

Gravitational field is a conservative force field. In a conservative force field work done is path independent.

$\therefore \qquad W_1 = W_2 = W_3$

197 (d)

$R = u\sqrt{\frac{2h}{g}} \Rightarrow 20 = V_1\sqrt{\frac{2\times 5}{10}}$ and $100 = V_2\sqrt{\frac{2\times 5}{10}}$

$\Rightarrow V_1 = 20\ m/s, V_2 = 100\ m/s$

Applying momentum conservation just before and just after the collision $(0.01)(V) = (0.2)(20) + (0.01)(100)$

$V = 500\ m/s$

198 (d)

Here, $m_1 = 20$ kg,

$m_2 = 0.1$ kg,

$v_1 =$ velocity of recoil of gun,

$v_2 =$ velocity of bullet

As $m_1 v_1 = m_2 v_2$

$v_1 = \frac{m_2}{m_1}v_2 = \frac{0.1}{20}v_2 = \frac{v_2}{200}$

Recoil energy of gun$= \frac{1}{2}m_1 v_1^2$

$= \frac{1}{2} \times 20\left(\frac{v_2}{200}\right)^2$

$804 = \frac{10v_2^2}{4\times 10^4} = \frac{v_2^2}{4\times 10^3}$

$v_2 = \sqrt{804 \times 4 \times 10^3}\,\text{ms}^{-1}$

199 (a)

$U = -\int F dx = -\int kx\, dx = -k\frac{x^2}{2}$

This is the equation of parabola symmetric to U axis in negative direction

200 (a)

$dW = F dl$

$W = \int_0^l F\, dl \quad Y = \frac{FL}{dl}$

or $W = \int_0^l \frac{Y\,al}{L}dl$ or $F = \frac{Y\,al}{L}$

or $W = \frac{Ya}{L}\int_0^l dl$ or $W = \frac{Ya}{L}\left(\frac{l^2}{2}\right)$

or $W = \frac{1}{2}\frac{Y\,al}{L}l = \frac{1}{2}Fl$

201 (a)

In head on elastic collision velocity get interchanged (if masses of particle are equal) *i.e.* the last ball will move with the velocity of first ball *i.e.* $0.4\ m/s$

203 (b)
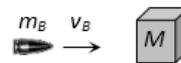
Initial K.E. of system = K.E. of the bullet $= \frac{1}{2}m_B v_B^2$

By the law of conservation of linear momentum

$m_B v_B + 0 = m_{\text{sys.}} \times v_{\text{sys.}}$

$\Rightarrow v_{\text{sys.}} = \frac{m_B v_B}{m_{\text{sys.}}} = \frac{50 \times 10}{50 + 950} = 0.5\ m/s$

Fractional loss in K.E. $= \frac{\frac{1}{2}m_B v_B^2 - \frac{1}{2}m_{\text{sys.}}v_{\text{sys.}}^2}{\frac{1}{2}m_B v_B^2}$

By substituting $m_B = 50 \times 10^{-3} kg, v_B = 10\ m/s$

$m_{\text{sys.}} = 1kg, v_s = 0.5\ m/s$ we get

Fractional loss $= \frac{95}{100}$ $\therefore$ Percentage loss $= 95\%$

204 (d)

$h_n = he^{2n} = 1 \times e^{2\times 1} = 1 \times (0.6)^2 = 0.36\ m$

205 (c)

There is no displacement

207 (c)

Potential energy U$= \frac{1}{2}kx^2$

$\therefore \frac{U_1}{U_2} = \left(\frac{x_1}{x_2}\right)^2$

Or$\frac{U}{U_2} = \left(\frac{1}{4}\right)^2$

Or $U_2 = 16\ U$

208 (c)

As slope of problem graph is positive and constant upto certain distance and then it becomes zero

So from $F = \frac{-dU}{dx}$, up to distance a,

$F =$ constant (negative) and becomes zero suddenly

209 (b)

Total mechanical energy= mgh

As, $\qquad \frac{\text{KE}}{\text{PE}} = \frac{2}{1}$

$\text{KE} = \frac{2}{3}\text{mgh}$

and $\quad$ PE $= \frac{1}{3}mgh$

Height from the ground at this instant,

$h' = \frac{h}{3}$ and speed of particle at this instant,

$v = \sqrt{2g(h - h')}$

$= \sqrt{2g\left(\frac{2h}{3}\right)}$

$= 2\sqrt{\frac{gh}{3}}$

210 (b)

The instantaneous power is the limiting value of the average power as the time interval Δt approaches zero.

$P = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t}$

$\therefore W = \int P \, dt$

Given $P = 3t^2 - 2t + 1$

$\therefore W = \int_2^4 (3t^2 - 2t + 1) \, dt$

$W = [t^3 - t^2 + t]_2^4 = 56 - 12 + 2$

$\implies \quad W = 46 \, J$

211 (c)

Power,

$p = m \times a \times v$

$p = m \times \frac{v^2}{t}$

If p is constant, then for a given body $v^2 \propto \sqrt{t}$

Or $v \propto \sqrt{t}$

212 (a)

By the particle of conservation of linear momentum,

$Mv = mv_1 + mv_2 \Rightarrow Mv = 0 + (M - m)v_2 \Rightarrow v_2$

$= \frac{Mv}{M - m}$

213 (d)

Initial momentum $= \vec{P} = mv\hat{\imath} + mv\hat{\jmath}$

$|\vec{P}| = \sqrt{2}mv$

Final momentum $= 2m \times V$

By the law of conservation of momentum

$2m \times V = \sqrt{2} \, mv \Rightarrow V = \frac{v}{\sqrt{2}}$

In the problem $v = 10 \, m/s$ [Given] $\therefore V = \frac{10}{\sqrt{2}} = $

$5\sqrt{2} \, m/s$

214 (c)

Work done on the ball by the table surface is the work done by the frictional force. Since a ball moves on a frictionless inclined table (or smooth

surface), therefore frictional force is zero. Hence the work done on the ball by the table surface is zero

215 (a)

In a perfectly elastic collision the relative velocity remains unchanged in magnitude but reserved in direction. Therefore , velocity of heavy body after collision is v.

216 (b)

Tension in the string

$T = M(g - a) = M\left(g - \frac{g}{2}\right) = \frac{Mg}{2}$

$W = $ Force $\times$ displacement

$= -\frac{Mgh}{2}$

217 (d)

Condition for vertical looping

$h = \frac{5}{2}r = 5cm \therefore r = 2 \, cm$

218 (a)

As particle is projected with some velocity therefore its initial kinetic energy will not be zero As it moves downward under gravity then its velocity increases with time K. E. $\propto v^2 \propto t^2$ [As $v \propto t$]

So the graph between kinetic energy and time will be parabolic in nature

219 (c)

$P = \sqrt{2mE} \therefore P \propto \sqrt{m}$ (if $E = $ const) $\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}}$

220 (b)

$v = 36 \, km/h = 10 \, m/s$

By law of conservation of momentum

$2 \times 10 = (2 + 3)V \Rightarrow V = 4 \, m/s$

Loss on K.E. $= \frac{1}{2} \times 2 \times (10)^2 - \frac{1}{2} \times 5 \times (4)^2 = 60 \, J$

221 (a)
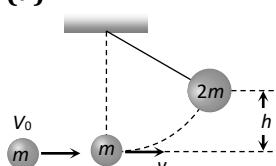
Initial momentum of particle $= mV_0$

Final momentum of system (particle +pendulum) $= 2mv$

By the law of conservation of momentum

$\Rightarrow mV_0 = 2mv \Rightarrow$ Initial velocity of system $v = \frac{V_0}{2}$

$\therefore$ Initial K.E. of the system $= \frac{1}{2}(2m)v^2 = $

$\frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2$

If the system rises up to height h then P.E. $= 2mgh$

By the law of conservation of energy

$$\frac{1}{2}(2m)\left(\frac{V_0}{2}\right)^2 = 2mgh \Rightarrow h = \frac{V_0^2}{8g}$$

222 (c)

From work energy theorem, $\Delta\,\text{KE} = W_{\text{net}}$

$$K_f - K_i = \int P\,dt$$

$$\frac{1}{2}mv^2 - 0 = \int_0^2 \left(\frac{3}{2}t^2\right)dt \text{ or } \frac{1}{2}(2)v^2 = \frac{3}{2}\left[\frac{t^3}{3}\right]_0^2 = 4$$

$$v = 2\text{ ms}^{-1}$$

223 (c)

$E = \frac{1}{2}mv^2$. Differentiating $w.r.t.\,x$, we get

$$\frac{dE}{dx} = \frac{1}{2}m \times 2v\frac{dv}{dx} = mv \times \frac{dv}{dt} \times \frac{dt}{dx} = mv \times \frac{a}{v}$$
$$= ma$$

224 (b)

Initial velocity of particle, $v_i = 20\text{ ms}^{-1}$

Final velocity of the particle, $v_f = 0$

According to work-energy theorem,

$$W_{\text{net}} = \Delta\text{KE} = K_f - K_i$$
$$= \frac{1}{2}m(v_f^2 - v_i^2)$$
$$= \frac{1}{2} \times 2(0^2 - 20^2)$$
$$= -400\text{ J}$$

225 (a)

Motor makes 600 revolution per minute

$$\therefore n = 600\frac{\text{revolution}}{\text{minute}} = 10\frac{rev}{sec}$$

$\therefore$ Time required for one revolution $= \frac{1}{10}\ sec$

Energy required for one revolution = power $\times$ time

$$= \frac{1}{4} \times 746 \times \frac{1}{10} = \frac{746}{40}\ J$$

But work done = 40% of input

$$= 40\% \times \frac{746}{40} = \frac{40}{100} \times \frac{746}{40} = 7.46\ J$$

226 (a)

Power of gun $= \frac{\text{Total K.E.of fired bullet}}{\text{time}}$

$$= \frac{n \times \frac{1}{2}mv^2}{t} = \frac{360}{60} \times \frac{1}{2} \times 2 \times 10^{-2} \times (100)^2$$
$$= 600\ W$$

227 (c)

$$p = \sqrt{2ME}\ \ \therefore \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}\frac{E_1}{E_2}} = \sqrt{\frac{2}{1} \times \frac{8}{1}} = \frac{4}{1}$$

228 (d)

Velocity at B when dropped from A where $AC = S$

$$v^2 = 0 + 2g(S - x)$$

Or $v^2 = 2g(S - x)$ ...(i)

Potential energy at $B = mgx$ ...(ii)
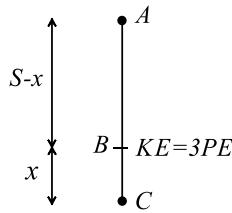
$\because$ Kinetic energy = 3 $\times$ potential energy

$$\therefore \frac{1}{2}m \times 2g(S - x) = 3 \times mgx$$

$$\Rightarrow S - x = 3x \text{ or } S = 4x \text{ or } x = S/4$$

From (i),

$$v^2 = 2g(S - x) = 2g\left(S - \frac{S}{4}\right) = \frac{2g \times 3S}{4} = \frac{3gS}{2}$$

$$\Rightarrow v = \sqrt{\frac{3gS}{2}}\ \ \therefore x = \frac{S}{4} \text{ and } v = \sqrt{\frac{3gS}{2}}$$

229 (c)

Kinetic energy $= \frac{1}{2}mv^2$

$$\therefore \text{K. E.} \propto v^2$$

If velocity is doubled then kinetic energy will become four times

230 (c)

When the block moves vertically downward with acceleration $\frac{g}{4}$ then tension in the cord

$$T = M\left(g - \frac{g}{4}\right) = \frac{3}{4}Mg$$

Work done by the cord $\vec{F}.\vec{S} = FS\cos\theta$

$$= Td\cos 180°$$
$$= \left(-\frac{3}{4}Mg\right) \times d = -3Mg\frac{d}{4}$$

231 (b)

Power delivered to body

P=F$\cdot v$

=mav

=ma(0 + gt)   ($\because u = o$)

$= magt$

Or $P \propto t$

232 (b)

Power delivered to the body

$$P = F.v = mav$$

Since, body undergoes one dimensional motion and is initially at rest, so

$$v = 0 + at$$

$$\therefore P = ma^2t \text{ or } P \propto t$$

234 (d)

Work done in raising water $= mgh$

$\therefore W = (\text{ volume} \times \text{density})\,gh = (9 \times 1000) \times 10 \times 10$

$$\Rightarrow W = 9 \times 10^5\ J$$

$\therefore$ Useful power $= \frac{\text{work}}{\text{time}} = \frac{9 \times 10^5}{5 \times 60} = 3kW$

$\therefore$ Efficiency $= \frac{3}{10} = 30\%$

235 (c)

When block of mass M collides with the spring its kinetic energy gets converted into elastic potential energy of the spring

From the law of conservation of energy

$$\frac{1}{2}Mv^2 = \frac{1}{2}KL^2 \quad \therefore v = \sqrt{\frac{K}{M}}L$$

Where v is the velocity of block by which it collides with spring. So, its maximum momentum

$$P = Mv = M\sqrt{\frac{K}{M}}L = \sqrt{MK}L$$

After collision the block will rebound with same linear momentum

236 (d)

In an inelastic collision, the particles do not regain their shape and size completely after collision. Some fraction of mechanical energy is retained by the colliding particles in the form of deformation potential energy .Thus the kinetic energy of particles no longer remains conserved .However, in the absence of external forces, law of conservation of linear momentum still holds good.

237 (a)

Let mass A moves with velocity v and collides inelastically with mass B, which is at rest
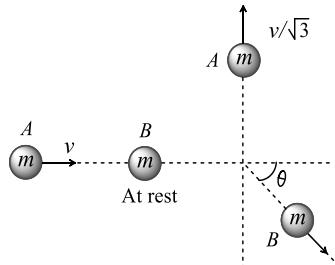
According to problem mass A moves in a perpendicular direction and let the mass B moves at angle θ with the horizontal with velocity v

Initial horizontal momentum of system (before collision) $= mv$ ....(i)

Final horizontal momentum of system (after collision) $= mV\cos\theta$ ....(ii)

From the conservation of horizontal linear momentum

$mv = mV\cos\theta \Rightarrow v = V\cos\theta$ ...(iii)

Initial vertical momentum of system (before collision) is zero

Final vertical momentum of system $\frac{mv}{\sqrt{3}} - mV\sin\theta$

From the conservation of vertical linear momentum

$\frac{mv}{\sqrt{3}} - mV\sin\theta = 0 \Rightarrow \frac{v}{\sqrt{3}} = V\sin\theta$ ...(iv)

By solving (iii) and (iv)

$$v^2 + \frac{v^2}{3} = V^2(\sin^2\theta + \cos^2\theta)$$

$$\Rightarrow \frac{4v^2}{3} = V^2 \Rightarrow V = \frac{2}{\sqrt{3}}v$$

238 (d)

$$s = \frac{u^2}{2\mu g} = \frac{10 \times 10}{2 \times 0.5 \times 10} = 10m$$

239 (c)

$$E = \frac{1}{2}mg^2 t^2$$

$$\frac{E_1}{E_2} = \frac{\frac{1}{2}mg^2 \times 3^2}{\frac{1}{2}mg^2(6^2 - 3^2)} = \frac{9}{9 \times 3} = \frac{1}{3}$$

241 (c)

P.E. of bob at point $A = mgl$

This amount of energy will be converted into kinetic energy
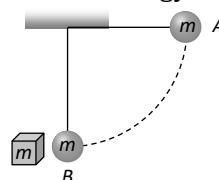
$\therefore$ K.E. of bob at point $B = mgl$

And as the collision between bob and block (of same mass) is elastic so after collision bob will come to rest and total Kinetic energy will be transferred to block. So kinetic energy of block $= mgl$

242 (b)

Momentum of third part will be equal to the resultant of momenta of two part

$$P_3^2 = P_1^2 + P_2^2$$

Or $p_3 = \sqrt{P_1^2 + P_2^2}$

Or $3mv_3 = \sqrt{(m \times 30)^2 + (m \times 30)^2}$

Or $v_3 = \frac{30\sqrt{2}}{3} 10\sqrt{2}ms^{-1}$

243 (a)

Initial KE of the system is zero, as both bullet and solid block are at rest .Final KE of the system increases.

Hence, in this process only momentum is conserved.

244 (d)

$$P = \frac{mgh}{t}$$

$\frac{M}{t} = $ mass of water fall per second

$$= \frac{P}{gh} = \frac{1 \times 10^6}{10 \times 10} = 10^4 \text{kg s}^{-1}$$

245 (d)

$$W = \int_0^2 F\, ds = \int_0^2 Ma\, ds = \int_0^2 M\frac{d^2s}{dt^2}\, ds$$

$$= \int_0^2 M\frac{d^2s}{dt^2}\cdot\frac{ds}{dt}\, dt$$

$$= \int_0^2 3\left(\frac{2}{3}\right)\cdot\left(\frac{2}{3}t\right) dt$$

$$= \frac{4}{3}\left[\frac{t^2}{2}\right]_0^2$$

$$W = \frac{4}{3} \times \frac{4}{2} = \frac{8}{3} = 2.6 \text{ J}$$

246 (b)

Let v_M is velocity of man, v_B of boy, then kinetic energy according to question ,

$$ie\, K = \frac{1}{2}Mv_M^2 = \frac{1}{2}\cdot\frac{M}{2}\cdot v_B^2$$

Or $v_M^2 = \frac{v_B^2}{2}$

Or $\sqrt{2}v_M = v_B$

When man speeds up $2\, ms^{-1}$ and boy changes his speed by $x ms^{-1}$. Then ,

$$\frac{1}{2}M(v_M + 2)^2 = \frac{1}{2}\cdot\frac{M}{2}\cdot(v_B + x)^2$$

Or $(v_M + 2)^2 = \frac{(v_B+x)^2}{2}$

$2(v_M + 2)^2 = \left(\sqrt{2}v_M + x\right)^2 (\because v_B = \sqrt{2}v_m)$

Or $\sqrt{2}(v_M + 2) = \sqrt{2}v_M + x$

Or $+2\sqrt{2} = x$

247 (a)

In an inelastic collision, only momentum is conserved whereas in elastic collision both momentum and kinetic energy are conserved

248 (b)

Kinetic energy $K = \frac{1}{2}mr^2\omega^2$

$ie,\qquad\qquad K \propto r^2$

The ratio of new kinetic energy to the original KE is given

$$\frac{K_2}{K_1} = \left(\frac{r_2}{r_1}\right)^2$$

249 (c)

In the given condition tension in the string
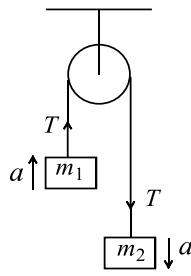
$$T = \frac{2m_1 m_2}{m_1 + m_2}g = \frac{2 \times 0.36 \times 0.72}{1.08} \times 10$$

$$T = 4.8\, N$$

And acceleration of each block

$$a = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)g = \left(\frac{0.72 - 0.36}{0.72 + 0.36}\right)g = \frac{10}{3}\, m/s^2$$

Let 'S' is the distance covered by block of mass $0.36\, kg$ in first sec

$$S = ut + \frac{1}{2}at^2 \Rightarrow S = 0 + \frac{1}{2}\left(\frac{10}{3}\right) \times 1^2$$

$$= \frac{10}{6}\, meter$$

$\therefore$ Work done by the string $W = TS = 4.8 \times \frac{10}{6}$

$\Rightarrow W = 8\, Joule$

250 (c)
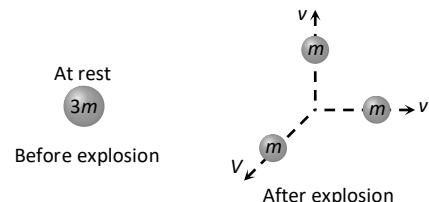
Initial momentum of $3m$ mass $= 0$ …(i)

Due to explosion this mass splits into three fragments of equal masses

Final momentum of system $= m\vec{V} + mv\hat{\imath} + mv\hat{\jmath}$ …(ii)

By the law of conservation of linear momentum

$m\vec{V} + mv\hat{\imath} + mv\hat{\jmath} = 0 \Rightarrow \vec{V} = -v(\hat{\imath} + \hat{\jmath})$

251 (a)

Percentage of energy loss

$$= \frac{mg(2-1.5)}{mgh} \times 100$$

$$= \frac{mg(0.5)}{mg \times 2} \times 100$$

$$= 25\%$$

252 (d)

Both fragments will possess the equal linear momentum

$m_1 v_1 = m_2 v_2 \Rightarrow 1 \times 80 = 2 \times v_2 \Rightarrow v_2 = 40\, m/s$

$\therefore$ Total energy of system $= \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2$

$$= \frac{1}{2} \times 1 \times (80)^2 + \frac{1}{2} \times 2 \times (40)^2 = 4800\, J$$

$$= 4.8\, kJ$$

253 (c)

$$F = \frac{3}{10} mg$$

$$W = -F \, s \text{ or } W = -\frac{3}{10} mgs$$

or $W = -\frac{3}{10} \times 200 \times 10 \text{ J} = -600 \text{ J}$

254 **(d)**

Question is somewhat based on approximations.

Let mass of athlete is 65 kg.

Approx velocity is 10 ms^{-1}

So, KE $= \frac{65 \times 100}{2} = 3750 \, J$

So, option(d) is most probable answer.

255 **(b)**

$$dW = -\mu \left[\frac{M}{L} \right] gl \, dl$$

$$W = \int_0^{\frac{2L}{3}} -\frac{\mu Mg}{L} l \, dl$$

or $W = -\frac{\mu Mg}{L} \left| \frac{l^2}{2} \right|_0^{\frac{2L}{3}}$

or $W = -\frac{\mu Mg}{L} \left| \frac{4L^2}{9} - 0 \right|$

or $W = -\frac{2}{9} \mu MgL$

256 **(b)**

Work done = Area enclosed by $F - x$ graph

$= \frac{1}{2} \times (3 + 6) \times 3 = 13.5 \, J$

257 **(c)**

Initial momentum of the system $= mv - mv = 0$

As body sticks together $\therefore$ final momentum $= 2mV$

By conservation of momentum $2mV = 0 \therefore V = 0$

258 **(b)**

$$K = \frac{\text{mass}}{\text{length}} = \frac{dm}{dt}$$

$$\text{KE} = \frac{1}{2} mv^2 \Rightarrow \frac{d}{dt}(\text{KE}) = \frac{1}{2} \left(\frac{dm}{dt} \right) v^2$$

$$= \frac{1}{2} \left(\frac{dm}{dx} \times \frac{dx}{dt} \right) v^2$$

$$= \frac{1}{2} kvv^2 = \frac{1}{2} kv^3$$

259 **(b)**

$$K = \frac{1}{2} mv^2$$

$$v^2 = \frac{98 \times 2}{2} = 98$$

$$h = \frac{v^2}{2g} = \frac{98}{2 \times 9.8} = 5$$

$$K_1 = \frac{1}{2} mv^2 = \frac{1}{2} m \times 2gh$$

$\therefore \quad \frac{K_2}{K_1} = \frac{h_2}{h_1}$

Given $K_2 = \frac{K_1}{2}$

$\therefore \quad = \frac{K_1}{2K_1} = \frac{h_2}{5}$

$\therefore \quad h_2 = 2.5 \text{ m}$

260 **(c)**

Between two collisions direction of velocity of ball get reserved at the highest point

261 **(a)**

Both part will have numerically equal momentum and lighter part will have more velocity

262 **(c)**

Stopping distance $= \frac{\text{kinetic energy}}{\text{retarding force}} \Rightarrow s = \frac{1}{2} \frac{mu^2}{F}$

If lorry and car both possess same kinetic energy and retarding force is also equal then both come to rest in the same distance

263 **(b)**

Force F=$(2\hat{I}+15\hat{j}+6\hat{k})$N

Displacement s $= 10\hat{j}$m

$W = F\cdot s = (2\hat{I}+15\hat{j}+6\hat{k})\cdot (10\hat{j}) = 150$J

264 **(a)**

From Newton's second law,

$$F = \frac{dp}{dt}$$

If F=0,then $\frac{dp}{dt} = 0$

$\Rightarrow \quad p = constant$

Thus, if total external force acting on the system is zero, then linear momentum of the system remains conserved.

265 **(a)**

$$\vec{F}. d\vec{F} = (x\hat{i} + y\hat{j}).(dx\hat{i} + dy\hat{j})$$

$$= xdx + ydy$$

266 **(a)**

$$W = F \times s = F \times v \times t = 5 \times 2 \times 60 = 600 \, J$$

267 **(b)**

Total initial momentum=Total final momentum

$ie \quad m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$\therefore \quad M \times v + m \times 0 = Mv_1 + mv_2$

$or \quad Mv = Mv_1 + Mv_2$

Or $M(v - v_1) = mv_2 \quad \dots \dots (i)$

Again kinetic energy is also conserved.

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$\therefore \quad Mv^2 + m \times 0 = Mv_1^2 + mv_2^2$

$or \quad Mv^2 = Mv_1^2 + mv_2^2$

Or $M(v^2 - v_1^2) = mv_2^2 \quad \dots \dots (ii)$

Dividing Eq.(ii)by Eq.(i), we get

$$\frac{M(v^2 - v_1^2)}{M(v - v_1)} = \frac{mv_2^2}{mv_2}$$

Or $v + v_1 = v_2$

As $M \gg m,$ so $v_1 = v$

$\therefore \quad v_2 = v + v = 2v$

268 (b)
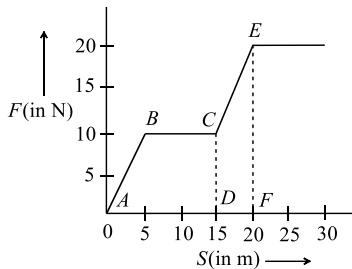
Work done W = area under $F - S$ graph

= area of trapezium $ABCD$ + area of trapezium $CEFD$

$= \dfrac{1}{2} \times (10 + 15) \times 10 + \dfrac{1}{2} \times (10 + 20) \times 5$

$= 125 + 75 = 200 \, J$

269 (a)

Both statements A and B given in the system are true.

270 (c)

Power of a pump $= \dfrac{1}{2} \, \rho A v^3$

To get twice amount of water from same pipe v has to be made twice. So power is to be made 8 times

271 (a)

As truck is moving on an incline plane therefore only component of weight ($mg \sin \theta$) will oppose the upward motion

Power = force × velocity = $mg \sin \theta \times v$

$= 30000 \times 10 \times \left(\dfrac{1}{100}\right) \times \dfrac{30 \times 5}{18} = 25 \, kW$

272 (d)

$s = 10$m, $F = 5$ N, $W = 25$ J, $\theta = ?$

$\cos \theta = \dfrac{W}{Fs} = \dfrac{25}{5 \times 10} = \dfrac{1}{2}$ $\therefore \theta = 60°$

273 (a)

The weight of bucket when it has been pulled up a distance x is $(5 - 0.2x)$.

Hence, the required work is

$W = \displaystyle\int_{x=20}^{x=0} -(5 - 0.2x) \times 10 \times dx$

$= [50x]_{x=0}^{x=20} - \left[2\dfrac{x^2}{2}\right]_{x=0}^{x=20}$

$W = 50 \times 20 - (20)^2 = 600$J

274 (b)

Work done W = Area $ABCEFDA$

$\qquad\qquad$ = Area $ABCD$ + Area $CEFD$
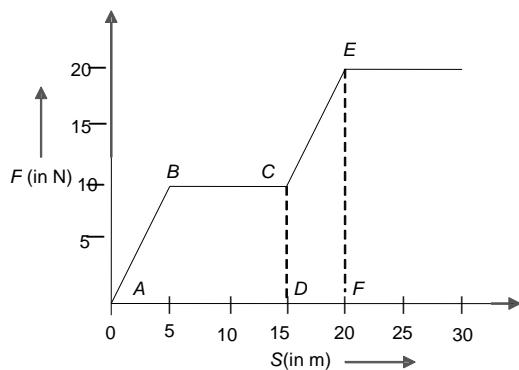
$= \dfrac{1}{2} \times (15 + 10) \times 10 + \dfrac{1}{2} \times (10 + 20) \times 5$

$= 125 + 75 = 200$J

275 (a)

If x is the extension produced in spring

$F = kx \Rightarrow x = \dfrac{F}{k} = \dfrac{mg}{k} = \dfrac{20 \times 9.8}{4000} = 4.9 \, cm$

276 (b)

Mass per unit length $= \dfrac{M}{L}$

$= \dfrac{4}{2} = 2 \text{kgm}^{-1}$
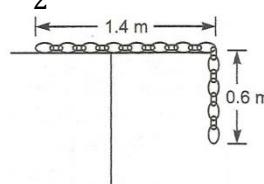
The mass of 0.6 m of chain

$= 0.6 \times 2 = 1.2$kg

$\therefore$ Center of mass of hanging part

$h = \dfrac{0.6 + 0}{2} = 0.3$m

Hence, work done in pulling the chain on the table = work done against gravity force

$W = mgh = 1.2 \times 10 \times 0.3 = 3.6$ J

277 (a)

$P = E \Rightarrow mv = \dfrac{1}{2} mv^2 \Rightarrow v = 2 \, m/s$

278 (c)

From work-energy theorem

$\Delta \text{KE} = W_{\text{net}}$

or $K_f - K_i = \int P \, d$

or $\dfrac{1}{2} mv^2 = \displaystyle\int_0^2 \left(\dfrac{3}{2} t^2\right) dt$

$v^2 = \left[\dfrac{t^3}{2}\right]_0^2$

$v = 2 \text{ ms}^{-1}$

279 (b)

Potential energy stored in the spring is given by

$U = \dfrac{1}{2} kx^2$

$\therefore \dfrac{U_1}{U_2} = \left(\dfrac{x_1}{x_2}\right)^2$

Or $\frac{100}{U_2} = \frac{(2)^2}{(4)^2}$

Or $U_2 = 400J$

∴ Potential energy increases by
400-100=300J

280 (b)

Given m= 5g = 0.005kg, h=19.5m,

$x = 50cm = 0.5m$, $v = 10ms^{-1}$, $g = 10ms^{-2}$

The change in mechanical energy

$\Delta U = mg(h + x) + \frac{1}{2}mv^2$

$= 0.005 \times 10(19.5 + 0.5) + \frac{1}{2} \times 0.005 \times (10)^2$

$= 0.005 \times 10 \times 20 + \frac{1}{2} \times 0.005 \times 100$

$= 1 + 0.25 = 1.25j$

281 (c)

$U = \frac{F^2}{2k} \Rightarrow \frac{U_1}{U_2} = \frac{k_2}{k_1}$ [If force are same]

$\therefore \frac{U_1}{U_2} = \frac{3000}{1500} = \frac{2}{1}$

282 (c)

Given, velocity of river,(v)=2m/s

Density of water p=1.2 gcc^{-1}

Mass of each cubic metre

$m = \frac{1.2 \times 10^{-3}}{(10^{-2})^3} = 1.2 \times 10^3 \text{kg}$

∴ kinetic energy= $\frac{1}{2}mv^2$

$= \frac{1}{2} \times 1.2 \times 10^3 \times (2)^2$

$= 2.4 \times 10^3 J = 2.4 \text{ KJ}$

283 (b)

Fractional decrease in kinetic energy of neutron

$= -\left(\frac{m_1-m_2}{m_1+m_2}\right)^2$ [As $m_1 = 1$ and $m_2 = 2$]

$= 1 - \left(\frac{1-2}{1+2}\right)^2 = 1 - \left(\frac{1}{3}\right)^2 = 1 - \frac{1}{9} = \frac{8}{9}$

284 (d)

Velocity of combined mass, $v = \frac{m_1v_1 - m_2v_2}{m_1+m_2}$

$= \frac{0.1 \times 1 - 0.4 \times 0.1}{0.5} = 0.12 \ m/s$

∴ Distance travelled by combined mass

$= v \times t = 0.12 \times 10 = 1.2 \ m$

285 (b)

$p = \sqrt{2mE_k}$

E_k is increased by a factor of 4, p becomes double.

So, percentage increase in momentum is 100%

286 (c)

Area of acceleration–displacement curve gives change in KE per unit mass

$\frac{1}{2}m(v^2 - u^2) = F.S = \frac{mdv}{dt} \times s$

$\therefore \frac{\text{change in } KE}{\text{Mass}} = \frac{dv}{dt} \times s$

287 (a)
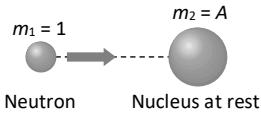
$\left(\frac{\Delta k}{k}\right)_{retained} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \left(\frac{1 - A}{1 + A}\right)^2$

288 (b)

$m_1 = 2 \ kg$ and $v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)u_1 = \frac{u_1}{4}$ [Given]

By solving we get $m_2 = 1.2 \ kg$

289 (a)

The potential energy of a particle is given by

$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right)$

For minimum value of V,$\frac{dV}{dx} = 0$

$\therefore \frac{4x^3}{4} - \frac{2x}{2} = 0 \implies x = 0, x = \pm 1$

So, $V_{MIN}(x = \pm 1) = \frac{1}{4} - \frac{1}{2} = \frac{-1}{4}J$

∴ $K_{MAX} + V_{MIN}$=Total mechanical energy

$K_{MAX} = \left(\frac{1}{4}\right) + 2 \implies K_{MAX} = \frac{9}{4}$

Or $\frac{mv^2}{2} = \frac{9}{4} \Rightarrow v = \frac{3}{\sqrt{2}}ms^{-1}$

290 (c)

Let$m$ = mass of boy,M = Mass of man

v = velocity of boy, V = velocity of man

$\frac{1}{2}MV^2 = \frac{1}{2}\left[\frac{1}{2}mv^2\right]$ ...(i)

$\frac{1}{2}M(V + 1)^2 = 1\left[\frac{1}{2}mv^2\right]$ ...(ii)

Putting $m = \frac{M}{2}$ and solving $V = \frac{1}{\sqrt{2}-1}$

291 (a)

$\vec{F} = \frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} = 7\hat{i} - 24\hat{j}$

$|\vec{F}| = \sqrt{(7)^2 + (-24)^2} = 25$ unit

292 (a)

Shell is fired with velocity v at an angle θ with the horizontal

So its velocity at the highest point

= horizontal component of velocity = $v \cos \theta$

So momentum of shell before explosion = $mv \cos \theta$
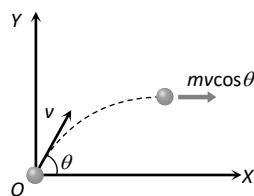
When it breaks into two equal pieces one piece retraces its path to the canon, then other part

moves with velocity V
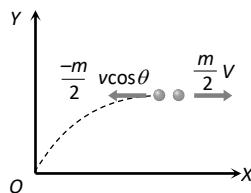
So momentum of two pieces after explosion
$$= \frac{m}{2}(-v\cos\theta) + \frac{m}{2}V$$
By the law of conservation of momentum
$$mv\cos\theta = \frac{-m}{2}v\cos\theta + \frac{m}{2}V \Rightarrow V = 3v\cos\theta$$

293 **(d)**

In perfectly elastic lead on collision of equal masses velocities gets interchanged

294 **(b)**
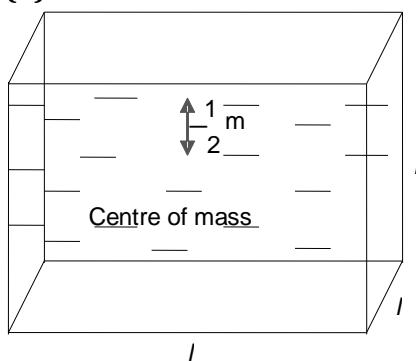
$V = I^3 = 1m^3$
$m = 1 \times 1000 = 1000$kg
$W = mgh = 1000 \times 10 \times \frac{1}{2} = 5000$ J

295 **(c)**

Force $F = (5 + 3x)$N
Work done $W = \int_{x_1}^{x_2} F.dx = \int_2^6 (5 + 3x)dx$
$$= \left[5x + \frac{3x^2}{2}\right]_2^6 = 68 \text{ J}$$

296 **(c)**

Vertical height $= h = l\cos 30°$
Loss of potential energy $= mgh$
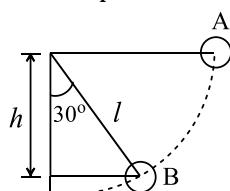
$= mgl\cos 30° = \frac{\sqrt{3}}{2}mgl$
$\therefore$ Kinetic energy gained $= \frac{\sqrt{3}}{2}mgl$

297 **(d)**

The potential energy of a stretched spring is
$$U = \frac{1}{2}kx^2$$

Here, k=spring constant, x=elongation in spring.
But given that, the elongation is 2 cm.
So $U = \frac{1}{2}K(2)^2$
Or $U = \frac{1}{2}k \times 4$ ...(i)
If elongation is 10 cm then potential energy
$$U' = \frac{1}{2}k(10)^2$$
Or $U' = \frac{1}{2}k \times 100$ ...(ii)
On dividing Eq. (ii) by Eq. (i), We have
$$\frac{U'}{U} = \frac{\frac{1}{2}k \times 100}{\frac{1}{2}k \times 4}$$
Or $\frac{U'}{U} = 25 \Rightarrow U' = 25U$

298 **(a)**

$$\text{Power} = \frac{\text{workdone}}{\text{time}} = \frac{\text{pressure} \times \text{cnahge in volume}}{\text{time}}$$
$$= \frac{20000 \times 1 \times 10^{-6}}{1} = 2 \times 10^{-2} = 0.02 \ W$$

299 **(a)**

Kinetic energy, $k = \frac{1}{2}mv^2$
$$= \frac{1}{2} \times \frac{m(mv^2)}{m}$$
$$= \frac{(mv^2)}{2m} \ or \ k = \frac{p^2}{2m}$$
$$= \frac{k_1}{k_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2}\frac{3}{1}$$
$$= \frac{p_1^2}{p_2^2} \times \frac{6}{2}$$
$p_1 : p_2 = 1 : 1$

300 **(a)**

$$v' = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)v$$
$$\left(\frac{1.008665 - 4.002603}{1.008665 + 4.002603}\right) \approx -\frac{3}{5}v$$

301 **(d)**

Given $F = 2x$,
Work done $W = \int F \, dx$
$$\therefore W = \int_{x_1}^{x_2} 2x \, dx = 2\left[\frac{x^2}{2}\right]_{x1}^{x2}$$
$$= (x_2^2 - x_1^2)$$

302 **(a)**

$$a = \frac{\text{Net pulling force}}{\text{Total mass}}$$
$$= \frac{0.72g - 0.36g}{0.72 + 0.36} = \frac{g}{3}$$
$$s = \frac{1}{2}at^2 = \frac{1}{2}\left(\frac{g}{3}\right)(1)^2 = \frac{g}{6}$$

$T - 0.36g = 0.36a = 0.36\frac{g}{3}$

$\therefore T = 0.48g$

Now, $w_T = TS\cos 0°$ (on 0.36 kg mass)

$= (0.48\,g)\left(\frac{g}{6}\right)(1) = 0.08(g^2)$

$= 0.08(10)^2 = 8J$
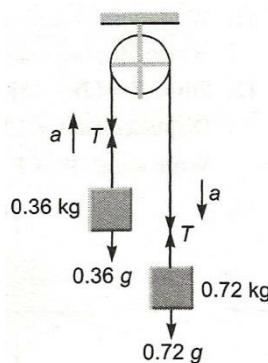
303 (c)

$P = Fv = m.\frac{dv}{dt}\cdot v$

$\int v\,dv = \int \frac{p}{m\,dt}; \quad \frac{v^2}{2} = \frac{pt}{m}$

$v = \sqrt{\frac{2p}{m}}\,t^{1/2}; \frac{dx}{dt} = \sqrt{\frac{2p}{m}}\,t^{1/2}$

$\int dx = \sqrt{\frac{2p}{m}}\int t^{1/2}dt;$

$x = \sqrt{\frac{2p}{3}}\frac{t^{3/2}}{3/2} = \frac{2}{3}\sqrt{\frac{2p}{3}}\,t^{3/2}$

$x \propto t^{3/2}$

305 (a)

$P = \left(\frac{m}{t}\right)gh = 100 \times 10 \times 100 = 10^5 W$

$= 100\,kW$

307 (b)

Here $t = \sqrt{x} + 3$

or $x = (t-3)^2 = t^2 - 6t + 9$

$v = \frac{dx}{dt} = 2t - 6$

At $t = 0$ s, $v = 2 \times 0 - 6 = -6$

At $t = 6$ s, $v = 2 \times 6 - 6 = +6$

Initial and final KE are same hence no work is done

$W = \frac{1}{2}m(v_1^2 - v_2^2) = 0$

308 (c)
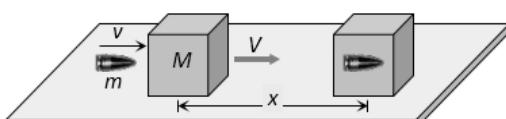
Let speed of the bullet $= v$

Speed of the system after the collision $= V$

By conservation of momentum $mv = (m + M)V$

$\Rightarrow V = \frac{mv}{M + m}$

So the initial K.E. acquired by the system

$= \frac{1}{2}(M + m)V^2 = \frac{1}{2}(m + M)\left(\frac{mv}{M+m}\right)^2$

$= \frac{1}{2}\frac{m^2 v^2}{(m + M)}$

This kinetic energy goes against friction work done by friction $= \mu R \times x = \mu(m + M)g \times x$

By the law of conservation of energy

$\frac{1}{2}\frac{m^2 v^2}{(m + M)} = \mu(m + M)g \times x \Rightarrow v^2$

$= 2\mu gx\left(\frac{m + M}{m}\right)^2$

$\therefore v = \sqrt{2\mu gx}\left(\frac{m + m}{m}\right)$

309 (a)

Given,

$m = 100$kg, $\quad$ h $= 10$m, $\quad$ t $= 5$s,

g $= 10\,ms^{-2}$ and η $= 60\%$

Power $= \frac{\text{work/time}}{\eta} = \frac{100}{60} \times \frac{mgh}{t}$

$= \frac{100}{60} \times \frac{100 \times 10 \times 10}{5}$

$= 3.3 \times 10^3 W$

$= 3.3$kW

310 (c)

$P = \frac{mgh}{t} \Rightarrow \frac{P_1}{P_2} = \frac{m_1}{m_2} \times \frac{t_2}{t_1}$ [As h $=$ constant]

$\therefore \frac{P_1}{P_2} = \frac{60}{50} \times \frac{11}{12} = \frac{11}{10}$

311 (c)

Loss in K.E. $= \frac{m_1 m_2}{2(m_1 + m_2)}(u_1 - u_2)^2$

$= \frac{4 \times 6}{2 \times 10} \times (12 - 0)^2 = 172.8\,J$

312 (a)

As surface is smooth so work done against friction is zero. Also the displacement and force of gravity are perpendicular so work done against gravity is zero

313 (c)

Let initially particle x is moving in anticlockwise direction and y in clockwise direction

As the ratio of velocities of x and y particles are $\frac{v_x}{v_y} = \frac{1}{2}$, therefore ratio of their distance covered will be in the ratio of 2 : 1. It means they collide at point B
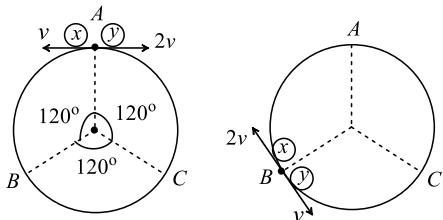
After first collision at B, velocities of particles get interchanged, $i.e.$, x will move with $2v$ and particle y with v

Second collision will take place at point C. Again at this point velocities get interchanged and third collision take place at point A

So, after two collision these two particles will again reach the point A

314 (c)

The work done in stretching a sprig by a length x,

$$W_1 = \frac{1}{2}kx^2 \qquad \ldots(i)$$

The work done in stretching the spring by a further length x.

$$W_2 = \frac{1}{2}k(2x)^2 - \frac{1}{2}kx^2$$

Or $\quad W_2 = \frac{1}{2}k \times 4x^2 - \frac{1}{2}kx^2$

Or $\quad W_2 = 3 \times \frac{1}{2}kx^2 \qquad \ldots(ii)$

From Esq. (i) and (ii)we have

$$W_2 = 3W_1$$

315 (b)

From conservation of energy,

Potential energy at height h = kinetic energy at ground

Therefore, at height h, potential energy of ball A

$PE = m_A gh$

KE at ground $= \frac{1}{2}m_A v_A^2$

So, $m_A gh = \frac{1}{2}m_A v_A^2$

$v_A = \sqrt{2gh}$

Similarly, $v_B = \sqrt{2gh}$

Therefore, $v_A = v_B$

316 (a)

$$P = \frac{mv^2}{2t} = \frac{80 \times 10 \times 10}{2 \times 4} = 1000W$$

317 (a)

$E = \frac{P^2}{2m}$ if $P =$constant then $E \propto \frac{1}{m}$

318 (b)

Momentum and kinetic energy is conserved only in this case

319 (b)

Before collision   After collision
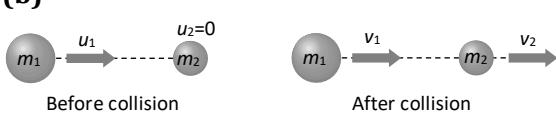
If target is at rest then final velocity of bodies are

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$ ...(i) and $v_2 = \frac{2m_1 u_1}{m_1 + m_2}$ ...(ii)

From (i) and (ii) $\frac{v_1}{v_2} = \frac{m_1 - m_2}{2m_1} = \frac{2}{5} \Rightarrow \frac{m_1}{m_2} = 5$

320 (c)

By the conservation of momentum in the absence of external force total momentum of the system (ball + earth) remains constant

321 (a)

For first condition

Initial velocity $= u$, final velocity $= u/2, s = 3\ cm$

From $v^2 = u^2 - 2as \Rightarrow \left(\frac{u}{2}\right)^2 = u^2 - 2as \Rightarrow a = \frac{3u^2}{8s}$

Second condition

Initial velocity $= u/2$, Final velocity $= 0$

From $v^2 = u^2 - 2ax \Rightarrow 0 = \frac{u^2}{4} - 2ax$

$\therefore x = \frac{u^2}{4 \times 2a} = \frac{u^2 \times 8s}{4 \times 2 \times 3u^2} = s/3 = 1cm$

322 (a)

Work done $W = \int_0^x F.\,dx$

$$= \int_0^x Cx\,dx = C\left(\frac{x^2}{2}\right)_0^x$$

$$= \frac{1}{2}Cx^2$$

323 (d)

The tension in the string at any position is

$$T = \frac{mv^2}{r} + mg\cos\theta$$

For critical position

$\theta = 180°$

$v = v_c$

T=0

Hence $\quad v_c\sqrt{rg}$
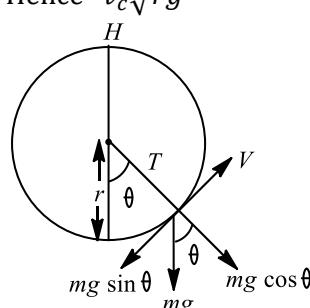
324 (c)

Let mass of boy be m. Therefore, mass of man $= 2\,m$, as

KE of man $= \frac{1}{2}$ KE of boy

$$\therefore \frac{1}{2}(2m)u^2 = \frac{1}{2} \times \frac{1}{2}mu'^2$$

$$u^2 = \frac{u'^2}{4}, u = \frac{u'}{2}$$

When man speeds up to 1 ms^{-1},
KE of man = KE of boy
$\frac{1}{2}(2m)(u+1)^2 = \frac{1}{2}mu'^2 = \frac{1}{2}m(2u)^2$
$(u+1)^2 = 2u^2$
$u+1 = \sqrt{2}u$
$u = \frac{1}{\sqrt{2}-1} = \frac{\sqrt{2}+1}{(\sqrt{2}-1)(\sqrt{2}+1)}$
$u = (\sqrt{2}+1)\text{ms}^{-1}$
$u' = 2u = 2(\sqrt{2}+1)\text{ms}^{-1}$

325 (c)
Velocity exchange takes place when the masses of bodies are equal

326 (c)
Let the thickness of one plank be s
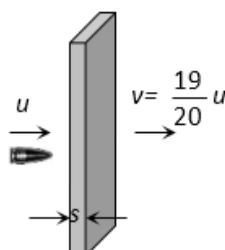
If bullet enters with velocity u then it leaves with velocity
$v = \left(u - \frac{u}{20}\right) = \frac{19}{20}u$
From $v^2 = u^2 - 2as$
$\Rightarrow \left(\frac{19}{20}u\right)^2 = u^2 - 2as \Rightarrow \frac{400}{39} = \frac{u^2}{2as}$
Now if the n planks are arranged just to stop the bullet then again from
$v^2 = u^2 - 2as$
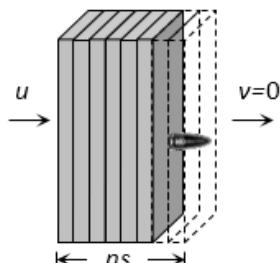
$0 = u^2 - 2ans$
$\Rightarrow n = \frac{u^2}{2as} = \frac{400}{39}$
$\Rightarrow n = 10.25$
As the planks are more than 10 so we can consider $n = 11$

327 (c)
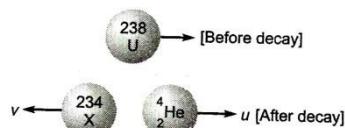
Apply conservation of linear momentum.

$0 = 4u - 234v$
$\Rightarrow v = \frac{4u}{234}$
The residual nucleus will recoil with a velocity of $\frac{4u}{234}$ unit.
Recoil speed of residual nucleus is $\frac{4u}{234}$

328 (a)
When the distance between atoms is large then interatomic force is very weak. When they come closer, force of attraction increases and at a particular distance force becomes zero. When they are further brought closer force becomes repulsive in nature
This can be explained by slope of $U - x$ curve shown in graph(a)

329 (a)
Initial energy of body $= \frac{1}{2}mv^2 = \frac{1}{2} \times 1 \times (20)^2 = 200\ J$
A part of this energy consumes in doing work against gravitational force and remaining part consumes in doing work against air friction
i.e., $W_T = W_{grav.} + W_{air\ friction}$
$\Rightarrow 200 = 1 \times 10 \times 18 + W_{air} \Rightarrow W_{air} = 20\ J$

330 (a)
Let v be the velocity with which the bullet will emerge
Now, change in kinetic energy = work done
For first case, $\frac{1}{2}m(100)^2 - \frac{1}{2}m \times 0 = F$
For second case, $\frac{1}{2}m(100)^2 - \frac{1}{2}mv^2 = F \times 0.5$
Dividing eq. (ii) by Eq. (i), we get
$\frac{(100)^2 - (v)^2}{(100)^2} = \frac{0.5}{1} = \frac{1}{2}$ or $v = \frac{100}{\sqrt{2}}$
$= 50\sqrt{2}\text{ms}^{-1}$

331 (b)
$W = Fs = F \times \frac{1}{2}at^2 \left[\text{from } s = ut + \frac{1}{2}at^2\right]$
$\Rightarrow W = F\left[\frac{1}{2}\left(\frac{F}{m}\right)t^2\right] = \frac{F^2t^2}{2m} = \frac{25 \times (1)^2}{2 \times 15} = \frac{25}{30}$
$= \frac{5}{6}J$

332 (b)
$v_1 = \sqrt{4^2 + 3^2} = \sqrt{25} = 5\text{ ms}^{-1}$
$v_2 = 6\text{ ms}^{-1}$
Work done = Increase in kinetic energy
$= \frac{1}{2} \times 2[6^2 - 5^2]J$
$= (36 - 25)J = 11\ J$

333 (d)

From law of conservation of linear momentum

Total final momentum =Total initial momentum

$m_1 v_1 + m_2 v_2 = 0$

Here, $m_1 = m_2$

So, $v_1 = -v_2$

So, both parts will move with same speed in opposite directions.

334 (b)

Here $a_c = \dfrac{v^2}{r} = k^2 rt \quad \because v = krt$

$\therefore v = krt$

The integral acceleration is $a_t = \dfrac{dv}{dt} = \dfrac{d(krt)}{dt} = kr$

The work done by centripetal force will be zero

So power is delivered to the particle by only tangential force which acts in the same direction of instantaneous velocity

$\therefore \text{Power} = F_y v = ma_t krt = m(kr)(krt)$

$\qquad = mk^2 r^2 t$

335 (d)

We can realize the situation as shown .Let at point C distance x from highest point A, the particle's kinetic energy is three times its potential energy.

$Velocity\ at\ C,$

$v^2 = 0 + 2gx$

$Or \quad v^2 = 2gx \qquad .....(i)$

Potential energy at C,$= mg\ (S - x) \ldots\ldots (ii)$
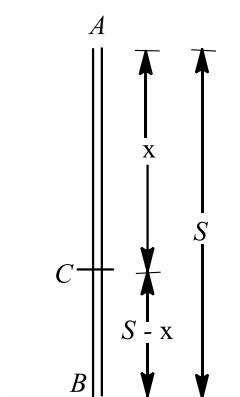
At Point C,

$\qquad$ Kinetic energy$=3\times potential\ energy$

ie,$\dfrac{1}{2} m \times 2gx = 3 \times mg(S - x)$

or $\qquad x = 3S - 3x$

or $\qquad 4x = 3S$

or $\qquad S = \dfrac{4}{3} x$

or $\qquad x = \dfrac{3}{4} S$

Therefore, from Eq.(i)

$\qquad\qquad v^2 = 2g \times \dfrac{3}{4} S$

Or $\qquad v^2 = \dfrac{3}{2} gS \ \ or \ v = \sqrt{\dfrac{3}{2} gS}$

Height of the particle from the ground

$= S - x = S - \dfrac{3}{4} S = \dfrac{s}{4}$

336 (b)

$W_1 = \dfrac{1}{2} k \times x_1^2$

$= \dfrac{1}{2} \times 5 \times 10^3 \times (5 \times 10^{-2})^2 = 6.25J$

$W_2 = \dfrac{1}{2} k(x_1 + x_2)^2$

$= \dfrac{1}{2} \times 5 \times 10^3 (5 \times 10^{-2} + 5 \times 10^{-2})^2 = 25\ J$

Net work done $= W_2 - W_1 = 25 - 6.25$

$= 18.75J = 18.75N - m$

337 (b)

According to the graph the acceleration a varies linearly with the coordinate x. We may write $a = \alpha x$, where α is the slope of the graph.

From the graph

$\alpha = \dfrac{20}{8} mg_0 = 2.5\ s^{-2}$

The force on the brick is in the positive x-direction and according to Newton's second law, its magnitude is given by

$F = \dfrac{a}{m} = \dfrac{\alpha}{m} x$

If x_f is the final coordinate, the work done by the force is

$W = \int\limits_0^{x_f} F\ dx = \dfrac{a}{m} \int_0^{x_f} x\ dx$

$= \dfrac{\alpha}{2m} x_f^2 = \dfrac{2.5}{2 \times 10} \times (8)^2$

$= 8\ J$

338 (c)

Average velocity $= \dfrac{100}{10} = 10\ m/s$

$K.E. = \dfrac{1}{2} m \times v^2 = \dfrac{1}{2} m \times (10)^2$

If $m = 40\ kg$, then $K.E. = 2000\ J$. If $m = 100 kg$, then $K.E. = 5000\ J$

So range will be $2000J - 5000J$

339 (d)

Initial K.E. of the body $= \dfrac{1}{2} mv^2 = \dfrac{1}{2} \times 25 \times 4 = 50\ J$

Work done against resistive force

$= \text{Area between } F\text{-}x\text{graph} = \dfrac{1}{2} \times 4 \times 20 = 40J$

Final K.E. = Initial K.E. – work done against resistive force

$= 50 - 40 = 10J$

340 (c)

$P = \vec{F}.\vec{v} = Fv \cos\theta$

Just before hitting θ is zero and both F, v are maximum

341 (a)

Since bodies exchange their velocities , hence their masses are equal so that $\frac{m_A}{m_B} = 1$

342 (d)

$v_1 = +3m/s$ $v_2 = -5m/s$
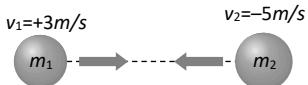
As $m_1 = m_2$ therefore after elastic collision velocities of masses get interchanged

$i.e.$ velocity of mass $m_1 = -5 \, m/s$

and velocity of mass $m_2 = +3 \, m/s$

343 (b)

$P = \frac{dW}{dt} = P\frac{dv}{dt}$

$P = h \, d \, \mathrm{g} = 10 \times 13.6 \times 980$

$= 1.3328 \times 10^5 \text{ dyne/cm}^2$

$\frac{dv}{dt}$ = Pulse frequency × blood discharged per pulse

$\frac{dv}{dt} = \frac{72}{60} \times 75 = 90$ cc/sec

$\therefore$ Power of heart $= 1.3328 \times 10^5 \times 90$ erg/sec

$= 1.19$ W

344 (b)

Efficiency, $\eta = \frac{\text{output power}}{\text{consuming power}} \times 100\%$

Here , $P_{\text{output}} = 10$kW

$P_{input} = 2 \times 10^3 \text{calg}^{-1} \times \text{gs}^{-1}$

$= 2 \times 10^3 \text{cals}^{-1}$

$= 2 \times 10^3 \times 4.2\text{Js}^{-1}$

8.4kW

As, $P_{output} > P_{input}$, hence it is never possible.

346 (d)

$S = \frac{t^3}{3} \therefore dS = t^2 dt \Rightarrow a = \frac{d^2 S}{dt^2} = \frac{d^2}{dt^2}\left[\frac{t^3}{3}\right]$

$= 2t \, m/s^2$

Now work done by the force $W = \int_0^2 F.dS = \int_0^2 ma.dS$

$\int_0^2 3 \times 2t \times t^2 dt = \int_0^2 6t^3 \, dt = \frac{3}{2}[t^4]_0^2 = 24 \, J$

347 (d)

$P = \vec{F}.\vec{v} = ma \times at = ma^2 t$ [as $u = 0$]

$= m\left(\frac{v_1}{t_1}\right)^2 t = \frac{mv_1^2 t}{t_1^2}$ [As $a = v_1/t_1$]

348 (c)

Work done by horizontal force

$W = F \times S = F \times l \sin\theta$ ....(i)

Increment in potential energy of mass M is

$U = Mgh = Mg(l - l\cos\theta) = Mgl(1 - \cos\theta)$

.....(ii)
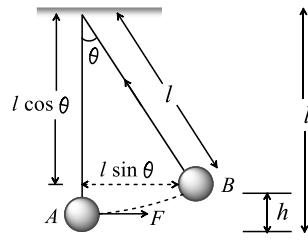
From equation (i) and (ii)

$Fl \sin\theta = Mgl(1 - \cos\theta)$

$\Rightarrow Fl\frac{1}{\sqrt{2}} = Mgl\left(1 - \frac{1}{\sqrt{2}}\right)$ [As $\theta = 45°$]

$\therefore F = Mg(\sqrt{2} - 1)$

349 (a)

Power of motor initially $= p_0$

Let, rate of flow of motor $= (x)$

Since, power, $p_0 = \frac{work}{time} = \frac{mgy}{t} = mg\left(\frac{y}{t}\right)$,

$\frac{y}{t} = x$ = rate of flow of water

$= mgx$ ....(i)

If rate of flow of water is increased by n times, $i.e.,$ (nx)

Increased power, $p_1 = \frac{mgy'}{t} = mg\left(\frac{y'}{t}\right)$,

$= nmgx$ ....(ii)

The ratio of power

$\frac{p_1}{p_0} = \frac{n \, mgx}{mgx} = \frac{n}{1} \Rightarrow p_1 : p_0 \Rightarrow n : 1$

350 (b)

The height (h) traversed by particle while going up is

$h = \frac{u^2}{2g} = \frac{25}{2 \times 9.8}$

$v = 0$

5 ms^{-1}

$100 \, g$

work done by gravity force$= mg.h$

$= 0.1 \times g \times \frac{25}{2 \times 9.8} \cos 180°$

[angle between force and displacement is 180°]

$\therefore \quad W = -0.1 \times \frac{25}{2} = -1.25 \text{ J}$

351 (c)

$w = \frac{F^2}{2k}$

If both springs are stretched by same force then $w \propto \frac{1}{k}$.

As $k_1 > k_2$ therefore, $w_1 < w_2$

I.e., more work is done in case of second spring.

353 (c)

$m_1 v_1 - m_2 v_2 = (m_1 + m_2)v$

$\therefore 2 \times 3 - 1 \times 4 = (2 + 1)v$

Or $v = \frac{2}{3}ms^{-1}$

354 **(c)**

$E = \frac{p^2}{2m}$ or $E \propto p^2$

or $\frac{E_1}{E_2} = \left(\frac{p_1}{p_2}\right)^2 = \left(\frac{p_1}{2p_2}\right)^2 = \frac{1}{2}$ or $E_2 = 4E_1$

So, increase is 300%

355 **(c)**

$\vec{F} = 3x^2\hat{i} + 4\hat{j},\ \vec{r} = x\hat{i} + y\hat{j}$

$\therefore d\vec{r} = dx\hat{i} + dy\hat{j}$

Work done, $W = \int \vec{F}.d\vec{r} = \int_{(2,3)}^{(3,0)}(3x^2\hat{i} + 4\hat{j}).(dx\hat{i} + dy\hat{j})$

$= \int_{(2,3)}^{(3,0)}(3x^2 dx + 4dy) = [x^3 + 4y]_{(2,3)}^{(3,0)}$

$= 3^3 + 4 \times 0 - (2^3 + 4 \times 3)$

$= 27 + 0 - (8 + 12) = 27 - 20 = +7J$

According to work energy theorem

Change in the kinetic energy = Work done, $W = +7J$

356 **(c)**

$v = \sqrt{(8)^2 + (6)^2} = 10ms^{-1}$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.4 \times 10 \times 10 = 20$ J

357 **(b)**

Let x be the maximum extension of the spring, figure. From conservation of mechanical energy; decreases in gravitational potential energy = increase in elastic potential energy
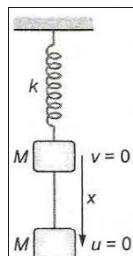
$Mg\, x = \frac{1}{2}k\, x^2$

$x = \frac{2\, Mg}{k}$

359 **(c)**

Potential energy $U = \frac{1}{2}kx^2$

$\therefore U \propto x^2$ [If k = constant]

If elongation made 4 times then potential energy will become 16 times

360 **(a)**

When the length of spring is halved, its spring constant will becomes double

$\left[\text{Because } k \propto \frac{1}{x} \propto \frac{1}{L} \therefore k \propto \frac{1}{L}\right]$

Slope of force displacement graph gives the spring constant (k) of spring

If k becomes double then slope of the graph increases $i.e.$ graph shifts towards force- axis

362 **(a)**

Since, linear momentum is conserved
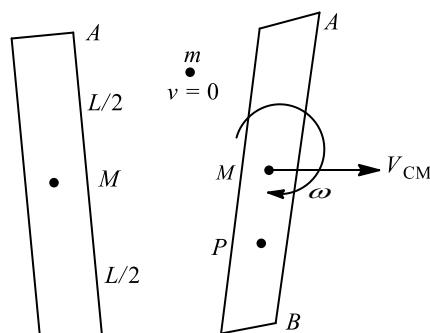
$mv_0 = Mv_{CM}$ .... (i)

Angular momentum is also conserved

$mv_0\frac{L}{2} = \frac{ML^2}{12}\omega$ ..... (ii)

Where $\frac{ML^2}{12}$ is the moment of inertia of the rod about the axis of rotation

Since, collision is completely elastic , kinetic energy is also conserved .Thus,

$\frac{1}{2}mv_0^2 = \frac{1}{2}M_{vCM} + \frac{1}{2}\left(\frac{ML^2}{12}\right)^2\omega^2$

From Eqs. (i)and (ii),We get

$v_{CM} = \frac{1}{6}\omega L$

Putting this value in Eq. (iii),we get

$\frac{1}{2}mv_0^2 = \frac{1}{2}M\left(\frac{1}{36}\omega^2 L^2\right) + \frac{1}{2}M\left(\frac{1}{12}\omega^2 L^2\right)$

$\frac{1}{18}M\omega^2 L^2$

OR $\frac{m}{M} = \frac{\omega^2 L^2}{9V_0^2}$

363 **(a)**

Kinetic energy is the energy possessed by a body due to its velocity(v)given by

$K = \frac{1}{2}mv^2$ ... (i)

Momentum(P)$= m \times v$ ... (ii)

Given, $K = p$

$\therefore \frac{1}{2}mv^2 = mv$ or $v = 2ms^{-1}$

364 **(a)**

Max. K.E. of the system = Max. P.E. of the system

$\frac{1}{2}kx^2 = \frac{1}{2} \times (16) \times (5 \times 10^{-2})^2 = 2 \times 10^{-2}J$

365 **(c)**

Initial height of CG$= \frac{a}{2}$

Final height of CG = $\frac{b}{2}$

Work done= $mg\left[\frac{b}{2} - \frac{a}{2}\right] = mg\left(\frac{b-a}{2}\right)$

366 **(a)**

Kinetic energy of the block is

$K = \frac{1}{2}mv^2$

This kinetic energy is equal to the work done by the block before coming to rest. The work done in compressing the spring through a distance x from its normal length is

$W = \frac{1}{2}kx^2$

$\therefore \quad \frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$\Rightarrow x = v\sqrt{\frac{m}{k}}$

Given, $v = 4m/s, m = 16 kg, k = 100$ N/m

$\therefore x = 4 \times \sqrt{\frac{16}{100}} = 1.6\ m$

367 **(b)**

In elastic collision

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$

If the second ball is at rest ,ie $u_2 = 0$,then

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$

$\frac{2}{3}u_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 \left[\because v_1 = \frac{2}{3}u_1\right]$

Or $2m_1 + 2m_2 = 3m_1 - 3m_2$

Or $m_1 = 5m_2$

Or $\frac{m_1}{m_2} = \frac{5}{1}$

369 **(d)**

Work done in raising water=mgh

$or\ W = (\text{volume} \times \text{density})gh$

$= (9 \times 1000) \times 10 \times 10$

Or $W = 9 \times 10^5$J

$\therefore$ Useful power $= \frac{\text{work}}{t} = \frac{9 \times 10^5}{5 \times 60} = 3kW$

Hence, efficiency=$\frac{\text{useful power}}{\text{consuming power}}$

$= \frac{3}{10} = 30\%$

370 **(d)**

Let a nucleus of mass M splits into two nuclear parts having masses M_1 and M_2 and radii R_1 and R_2 and densities ρ_1 and ρ_2

$\therefore M_1 = \rho_1\frac{4}{3}\pi R_1^3$ and $M_2 = \rho_2\frac{4}{3}\pi R_2^3$

Given: $\rho_1 = \rho_2$

$\therefore \frac{M_1}{M_2} = \left(\frac{R_1}{R_2}\right)^3$

According to law conservation of linear momentum,

$M \times 0 = M_1v_1 + M_2v_2$ or $\frac{M_1}{M_2} = -\frac{v_2}{v_1}$

$-ve$ sign show that both the parts are move in opposite direction in order to conserve the linear momentum

$\therefore \frac{v_1}{v_2} = \frac{M_2}{M_1}$ or $\frac{v_1}{v_2} = \left(\frac{R_2}{R_1}\right)^3$

$\frac{v_1}{v_2} = \left(\frac{2}{1}\right)^3 = \frac{8}{1}\left[\text{Given }\frac{R_1}{R_2} = \frac{1}{2}\right]$

371 **(c)**

Volume= $av = \pi r^2 v$

Mass = $\pi r^2 v \times 1000$ SI units

Power of water jet

$= \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2} \times \pi r^2 v \times 1000 \times v^2 = 500\pi r^2 v^3$

372 **(a)**

Impulse = change in momentum = 2 mv

$= 2 \times 0.06 \times 4 = 0.48\ kg\ m/s$

373 **(a)**

$m = 0.3 \times 10^8$ kg, $F = 0.5 \times 10^5$N, $s = 3m, v =?$

Work done= $F \times s$

This work becomes the kinetic energy of the ship

$\therefore \frac{1}{2}mv^2 = F \times s$

or $v^2 = \frac{2Fs}{m} = \frac{2\times 0.5\times 10^5 \times 3}{0.3\times 10^8}$ or $v = 0.1\text{ms}^{-1}$

374 **(a)**

$P = \frac{\vec{F}.\vec{s}}{t} = \frac{(2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}).(3\hat{\imath} + 4\hat{\jmath} + 5\hat{k})}{4} = \frac{38}{4}$

$= 9.5\ W$

375 **(a)**

Given $F = -5x - 16x^3 = -(5 + 16x^2)x = -kx$

where $k(= 5 + 16x^2)$ is force constant of spring ,Therefore , work done in stretching the spring from position x_1 to position x_2 is

$w = \frac{1}{2}k_2x_2^2 - \frac{1}{2}k_1x_1^2$

We have,$x_1 = 0.1$ m and $x_2 = 0.2$m.

$\therefore W = \frac{1}{2}[5 + 16(0.2)^2](0.2)^2$

$\qquad\qquad - \frac{1}{2}[5 + 16(0.1)^2](0.1)^2$

$=2.82 \times 4 \times 10^{-2} - 2.58 \times 10^{-2} = 8.7 \times 10^{-2}$J

376 **(d)**

$F = -\frac{\partial U}{\partial x}\hat{\imath} - \frac{\partial U}{\partial y}\hat{\jmath} = 7\hat{\imath} - 24\hat{\jmath}$

$\therefore a_x = \frac{F_x}{m} = \frac{7}{5} = 1.4\text{ ms}^{-2}$ along positive x-axis

$a_y = \frac{F_y}{m} = -\frac{24}{5}$

= 4.8ms^{-2} along negative y-axis

$\therefore v_x = a_x t = 1.4 \times 2$

$= 2.8$ ms^{-2}

and $v_y = 4.8 \times 2 = 9.6$ ms^{-1}

$\therefore v = \sqrt{v_x^2 + v_y^2} = 10$ ms^{-1}

377 (b)

$P = \dfrac{mgh}{t}$ or $\dfrac{m}{t} = \dfrac{P}{gh}$

or $\dfrac{m}{t} = \dfrac{1000}{10 \times 10}$ kg $= 10$ kg

378 (c)

A s first collision one particle having speed 2v will rotate

$240° \left(or \dfrac{4\pi}{3}\right)$ while other particle having speed

v will rotate

$120° \left(or \dfrac{2\pi}{3}\right)$. At first collision they will exchange their velocities. Now as shown in figure, after two collisions they will again reach at point A.
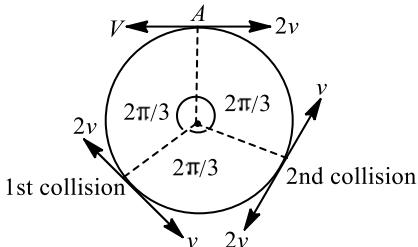
379 (c)

By definition

380 (a)

Here, Force, $\vec{F} = \left(4\hat{\imath} + \hat{\jmath} - 2\hat{k}\right)N$

Velocity, $\vec{v} = \left(2\hat{\imath} + 2\hat{\jmath} + 3\hat{k}\right)ms^{-1}$

Power, $P = \vec{F}.\vec{v} = \left(4\hat{\imath} + \hat{\jmath} - 2\hat{k}\right).\left(2\hat{\imath} + 2\hat{\jmath} + 3\hat{k}\right)$

$= (8 + 2 - 6)\,W = 4W$

381 (a)

Work done =area under curve and displacement axis

$= 1 \times 10 - 1 \times 10 + 1 \times 10 = 10\,J$

382 (d)

Loss in K.E. = (initial K.E. – Final K.E.)of system

$\dfrac{1}{2} m_1 u_1^2 + \dfrac{1}{2} m_2 u_2^2 - \dfrac{1}{2}(m_1 + m_2)V^2$

$= \dfrac{1}{2}\,3 \times (32)^2 + \dfrac{1}{2} \times 4 \times (5)^2 - \dfrac{1}{2} \times (3 + 4)$

$\qquad\qquad \times (5)^2$

$= 1498.5\,J$

383 (d)

Work done=force× displacement

Hence, displacement-force curve gives work done,

384 (a)

By conservation of energy, $mgh = \dfrac{1}{2}mv^2$

$\Rightarrow v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 1} = \sqrt{19.6} = 4.43\,m/s$

385 (b)

Work done $= mgh = 10 \times 9.8 \times 1 = 98\,J$

386 (b)

Gravitational potential energy of ball gets converted into elastic potential energy of the spring $mg(h + d) = \dfrac{1}{2}Kd^2$

Net work done $= mg(h + d) - \dfrac{1}{2}Kd^2 = 0$

387 (b)

$F = \dfrac{dp}{dt} = m\dfrac{dv}{dt} = \dfrac{m \times 2v}{1/50} = \dfrac{2 \times 2 \times 100}{1/50}$

$\qquad\qquad = 2 \times 10^4 N$

388 (a)

$P = \dfrac{W}{t} = \dfrac{mgh}{t} = \dfrac{200 \times 10 \times 50}{10} = 10 \times 10^3 W$

389 (a)
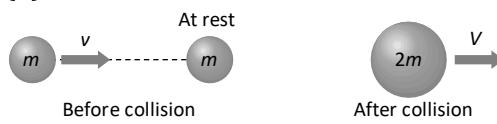
Initial momentum $= mv$

Final momentum $= 2mV$

By the conservation of momentum, $mv = 2mV$

$\Rightarrow V = \dfrac{v}{2}$

K.E. of the system after the collision $= \dfrac{1}{2}(2m)\left(\dfrac{v}{2}\right)^2$

$\therefore$loss in K.E. $= \dfrac{1}{2}\,mv^2 - \dfrac{1}{4}mv^2 = \dfrac{1}{4}mv^2$

This loss in K.E. will increase the temperature

$\therefore 2m \times s \times \Delta t = \dfrac{1}{4}mv^2 \Rightarrow \Delta t = \dfrac{v^2}{8s}$

390 (a)

$W = \displaystyle\int_A^B F_x\,dx \Rightarrow W = \int_{x=4}^{k=-2}(-6x^3)\,dx$

$= -6\left[\dfrac{x^4}{4}\right]_{x=4}^{x=-2} = \left(\dfrac{-3}{2}\right)(-240) = 360\,J$

391 (a)

Work done by the net force = change in kinetic energy of the particle

392 (c)

The displacement of body is

$\overrightarrow{AB} = \overrightarrow{r}_B - \vec{r}_A$

$= \left(3\hat{\imath} + 2\hat{\jmath} + 5\hat{k}\right) - (2\hat{\imath} + 3\hat{\jmath} + 4\hat{k})$

$= \hat{\imath} + \hat{\jmath} + \hat{k}$

$\therefore\ W = \vec{F}.\overrightarrow{AB} = (2\hat{\imath} - 4\hat{\jmath}).(\hat{\imath} - \hat{\jmath} + \hat{k})$

$= 2 - 4 = -2$ J

393 (b)

Loss of KE = force × distance $= (ma)x$

As $a \propto x$

$\therefore$ Loss of KE $\propto x^2$

394 (b)

$P =$ constant

$\Rightarrow Fv = P$ [∵ $P =$ force × velocity]

$\Rightarrow Ma \times v = P$ [∵ $F = Ma$]

$\Rightarrow va = \dfrac{P}{M}$

$\Rightarrow v \times \dfrac{vdv}{ds} = \dfrac{P}{M}\left[\because a = \dfrac{vdv}{ds}\right]$

$\Rightarrow \displaystyle\int_0^v v^2 dv = \int_0^s \dfrac{P}{M} ds$

[Assuming at $t = 0$ it starts from rest, *ie*, from $s = 0$]

$\Rightarrow \dfrac{v^3}{3} = \dfrac{P}{M} s$

$\Rightarrow v = \left(\dfrac{3P}{M}\right)^{1/3} \times s^{1/3}$

$\Rightarrow \dfrac{ds}{dt} = ks^{1/3} \left[k = \left(\dfrac{3P}{M}\right)^{1/3}\right]$

$\Rightarrow \displaystyle\int_0^s \dfrac{ds}{s^{1/3}} = \int_0^t kdt$

$\Rightarrow \dfrac{s^{2/3}}{2/3} = kt$

$\therefore s = \left(\dfrac{2}{3}k\right)^{3/2} \times t^{3/2}$

$\Rightarrow s \propto t^{3/2}$

395 (b)

Given ,m=2kg,v=3ms^{-1}, $K = 144 Nm^{-1}$

Let spring is compressed by a length x.

ie $\dfrac{1}{2}mv^2 = \dfrac{1}{2}kx^2$

$\therefore \dfrac{1}{2} \times 2 \times (3)^2 = \dfrac{1}{2} \times 144 \times x^2$

Or $9 = 72x^2$

Or $x = \sqrt{\dfrac{9}{72}} = \dfrac{1}{2\sqrt{2}} m$

Hence, length of compressed spring

$= 2 - \dfrac{1}{2\sqrt{2}}$

$= \dfrac{4\sqrt{2} - 1}{2\sqrt{2}} = 1.5m$

396 (a)

Momentum of earth-ball system remains conserved

397 (b)

$P = \dfrac{\text{total energy}}{t} = \dfrac{mgh + \frac{1}{2}mv^2}{t}$

$= \dfrac{10 \times 10 \times 20 + \frac{1}{2} \times 10 \times 10 \times 10}{1}$

$= 2000 + 500 = 2500\text{ W}$

$= 2.5\text{ kW}$

398 (a)

$p = \dfrac{mgh}{t} = \dfrac{200 \times 10 \times 200}{10} = 40\ kW$

399 (d)

Total mass $= (50 + 20) = 70\ kg$

Total height $= 20 \times 0.25 = 5m$

∴ Work done $= mgh = 70 \times 9.8 \times 5 = 3430\ J$

400 (a)

Let d_s be the distance travelled by the vehicle before it stops

Here, final velocity $v = 0$, initial velocity $= u$

Using equation of motion $v^2 = u^2 + 2aS$

$\therefore 0^2 = u^2 + 2ad_s$

Or Stopping distance, $d_s = -\dfrac{u^2}{2a}$

401 (a)

$P = \sqrt{2mE}$ ∴ $P \propto \sqrt{E}$ *i.e.*, if kinetic energy becomes four times then new momentum will become twice

402 (a)

Given a=$-kx$

$a = \dfrac{dv}{dt} = \dfrac{dv}{dx} \cdot \dfrac{dx}{dt} = -kx$

Or $\dfrac{vdv}{dx} = -kx$

Or $v\ dv = -kx\ dx$

Let for any displacement from 0 to x,the velocity changes from v_0 to v.

$\Rightarrow \displaystyle\int_{v0}^{v} vdv = -\int_0^x k\ x\ dx$

Or $\dfrac{v^2 - v_0^2}{2} = -\dfrac{kx^2}{2}$

or $m\left(\dfrac{v^2 - v_0^2}{2}\right) = -\dfrac{mkx^2}{2}$

Or $\Delta K \propto x^2$ (ΔK is loss in KE)

403 (b)

$KE = \dfrac{1}{2}mv^2$

Given, $v_2 = (v_1 + 2)$

$\dfrac{K_1}{K_2} = \left(\dfrac{v_1}{v_2}\right)^2$

$\dfrac{1}{2} = \dfrac{v_1^2}{(v_1 + 2)^2}$ (∵ $k_2 = 2k_1$)

$v_1^2 + 4v_1 + 4 = 2v_1^2$

$v_1^2 - 4v_1 - 4 = 0$

$v_1 = \dfrac{4 \pm \sqrt{16 + 16}}{2}$

$v_1 = \dfrac{4 + \sqrt{32}}{2} = 2(\sqrt{2} + 1)\text{ms}^{-1}$

404 (c)

The momentum of the two-particle system, at $t = 0$ is

$\vec{P}_i = m_1\vec{v}_1 + m_2\vec{v}_2$

Collision between the two does not affect the total momentum of the system

A constant external force $(m_1 + m_2)g$ acts on the system

The impulse given by this force, in time $t = 0$ to $t = 2t_0$

is $(m_1 + m_2)g \times 2t_0$

$\therefore$ Change in momentum in this interval

$= |m_1\vec{v}'_1 + m_2\vec{v}'_2 - (m_1\vec{v}_1 + m_2\vec{v}_2)|$

$\qquad\qquad = 2(m_1 + m_2)gt_0$

405 **(d)**

Here $k = \dfrac{F}{x} = \dfrac{10}{1\times10^{-3}} = 10^4 \ N/m$

$W = \dfrac{1}{2}kx^2 = \dfrac{1}{2} \times 10^4 \times (40 \times 10^{-3})^2 = 8J$

1) b	2) a	3) b	4) d	205) c	206) b	207) c	208) c
5) d	6) c	7) b	8) b	209) b	210) b	211) c	212) a
9) c	10) b	11) b	12) c	213) d	214) c	215) a	216) b
13) b	14) b	15) d	16) a	217) d	218) a	219) c	220) b
17) d	18) a	19) c	20) b	221) a	222) c	223) c	224) b
21) c	22) a	23) d	24) b	225) a	226) a	227) c	228) d
25) c	26) c	27) a	28) a	229) c	230) c	231) b	232) b
29) b	30) c	31) c	32) a	233) b	234) d	235) c	236) d
33) d	34) d	35) b	36) c	237) a	238) d	239) c	240) a
37) b	38) a	39) b	40) d	241) c	242) b	243) a	244) d
41) a	42) d	43) b	44) d	245) d	246) b	247) a	248) b
45) a	46) a	47) a	48) d	249) c	250) c	251) a	252) d
49) c	50) c	51) b	52) a	253) c	254) d	255) b	256) b
53) c	54) b	55) b	56) b	257) c	258) b	259) b	260) c
57) a	58) a	59) b	60) b	261) a	262) c	263) b	264) a
61) c	62) c	63) b	64) b	265) a	266) a	267) b	268) b
65) d	66) a	67) d	68) b	269) a	270) c	271) a	272) d
69) b	70) c	71) c	72) c	273) a	274) b	275) a	276) b
73) c	74) c	75) c	76) b	277) a	278) c	279) b	280) b
77) c	78) a	79) d	80) d	281) c	282) c	283) b	284) d
81) a	82) b	83) d	84) d	285) b	286) c	287) a	288) b
85) d	86) c	87) c	88) a	289) a	290) c	291) a	292) a
89) a	90) d	91) b	92) b	293) d	294) b	295) c	296) c
93) b	94) c	95) d	96) b	297) d	298) a	299) a	300) a
97) c	98) c	99) c	100) d	301) d	302) a	303) c	304) a
101) b	102) c	103) a	104) c	305) a	306) a	307) b	308) c
105) b	106) d	107) b	108) b	309) a	310) c	311) c	312) a
109) b	110) c	111) a	112) d	313) c	314) c	315) b	316) a
113) b	114) d	115) b	116) a	317) a	318) b	319) b	320) c
117) c	118) b	119) b	120) c	321) a	322) a	323) d	324) c
121) d	122) c	123) b	124) d	325) c	326) c	327) c	328) a
125) a	126) a	127) c	128) d	329) a	330) a	331) b	332) b
129) b	130) a	131) d	132) d	333) d	334) b	335) d	336) b
133) d	134) a	135) a	136) b	337) b	338) c	339) d	340) c
137) a	138) b	139) b	140) c	341) a	342) d	343) b	344) b
141) c	142) a	143) a	144) b	345) c	346) d	347) d	348) c
145) d	146) b	147) a	148) c	349) a	350) b	351) c	352) c
149) c	150) c	151) b	152) d	353) c	354) c	355) c	356) c
153) a	154) a	155) a	156) a	357) b	358) b	359) c	360) a
157) a	158) b	159) c	160) b	361) d	362) a	363) a	364) a
161) b	162) a	163) c	164) b	365) c	366) a	367) b	368) c
165) c	166) a	167) b	168) c	369) d	370) d	371) c	372) a
169) c	170) c	171) c	172) c	373) a	374) a	375) a	376) d
173) c	174) b	175) b	176) d	377) b	378) c	379) c	380) a
177) a	178) a	179) d	180) b	381) a	382) d	383) d	384) a
181) a	182) a	183) d	184) d	385) b	386) b	387) b	388) a
185) b	186) a	187) c	188) d	389) a	390) a	391) a	392) c
189) c	190) a	191) c	192) d	393) b	394) b	395) b	396) a
193) b	194) d	195) b	196) b	397) b	398) a	399) d	400) a
197) d	198) d	199) a	200) a	401) a	402) a	403) b	404) c
201) a	202) b	203) b	204) d	405) d			
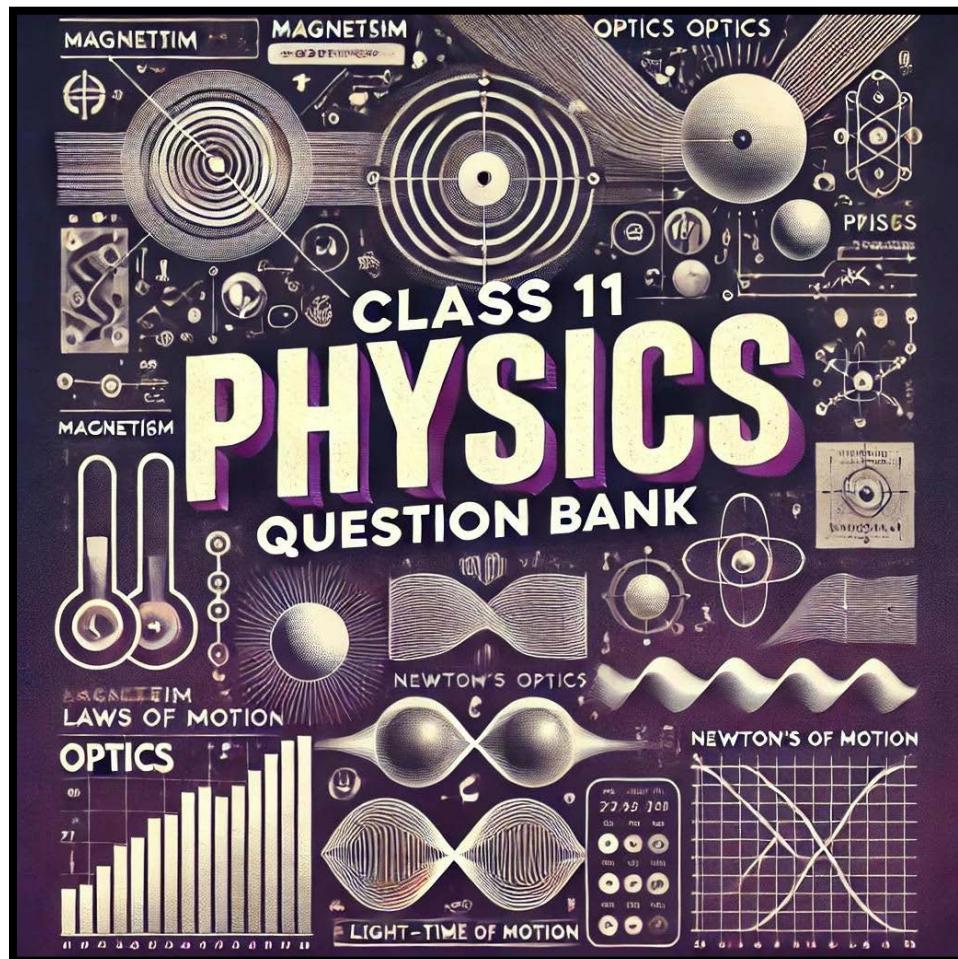
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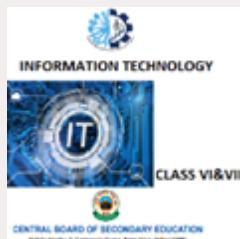
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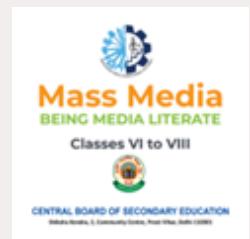
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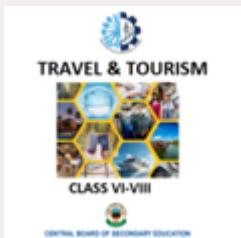
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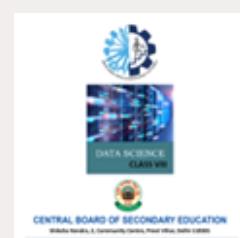
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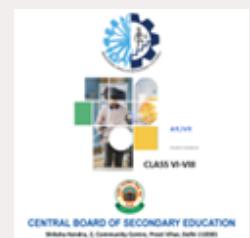
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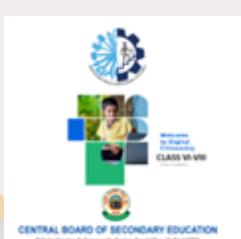
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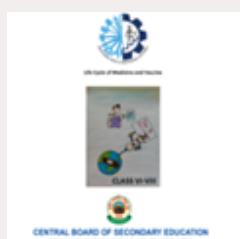
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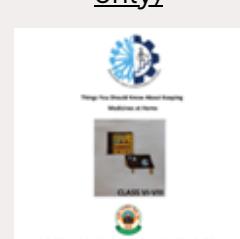
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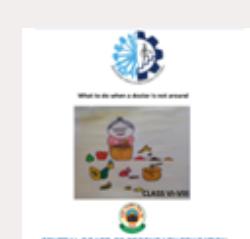
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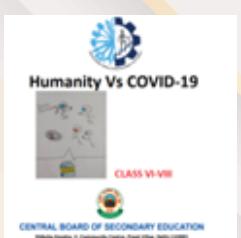
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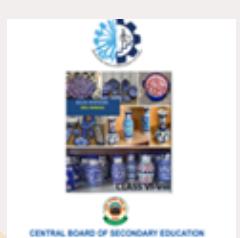
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Pottery

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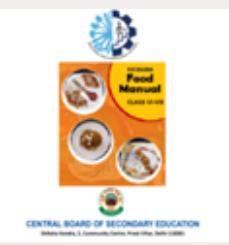
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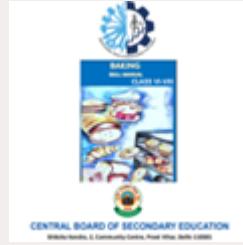
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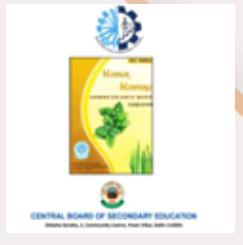
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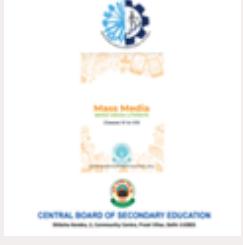
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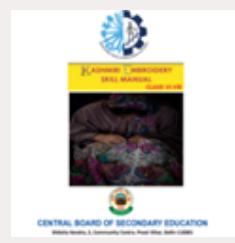
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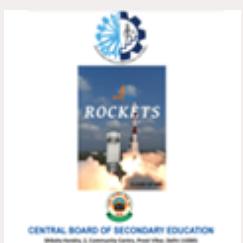
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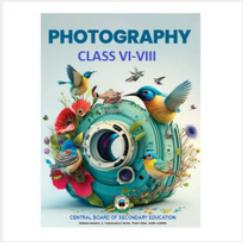
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Physical Activity Trainer

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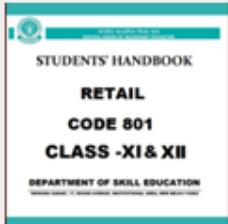
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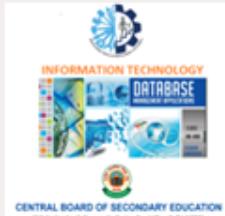
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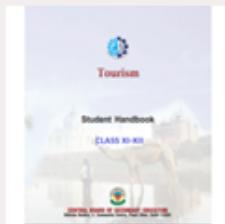
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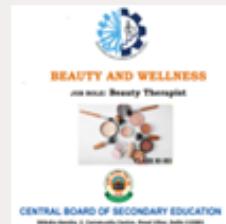
Beauty & Wellness
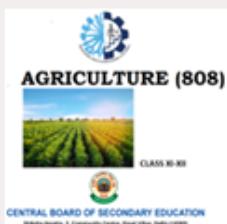
Agriculture

Food Production

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Health Care

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Horticulture
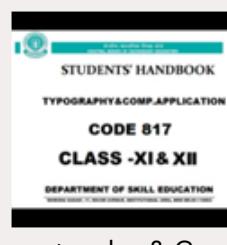
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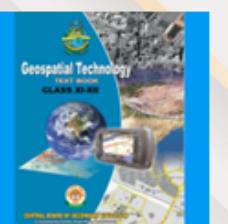
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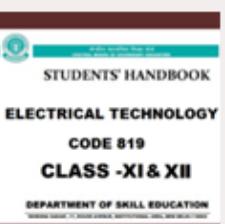
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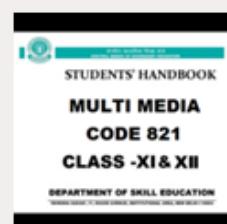
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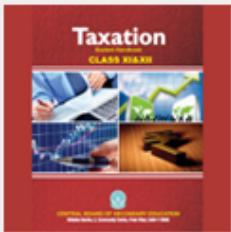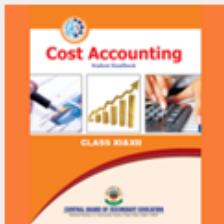
Taxation	Cost Accounting	Office Procedures & Practices	Shorthand (English)
Shorthand (Hindi)	Air-Conditioning & Refrigeration	Medical Diagnostics	Textile Design
Design	Salesmanship	Business Administration	Food Nutrition & Dietetics
Mass Media Studies	Library & Information Science	Fashion Studies	Applied Mathematics
Yoga	Early Childhood Care & Education	Artificial Intelligence	Data Science
Physical Activity Trainer(new)	Land Transportation Associate (NEW)	Electronics & Hardware (NEW)	Design Thinking & Innovation (NEW)
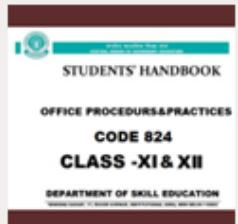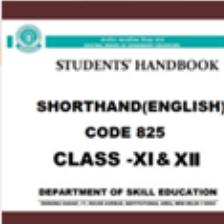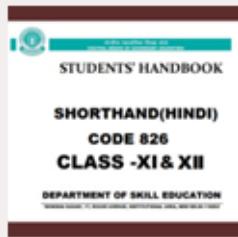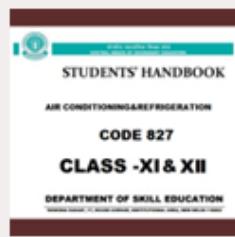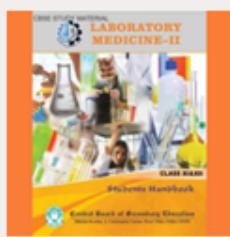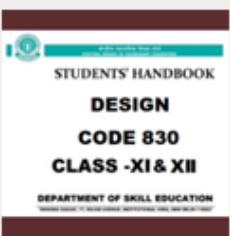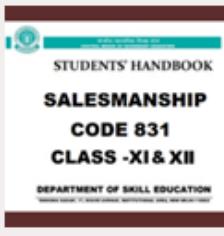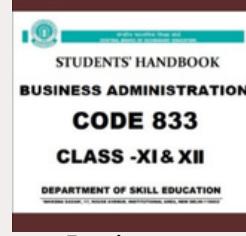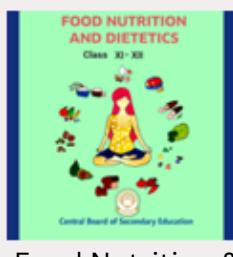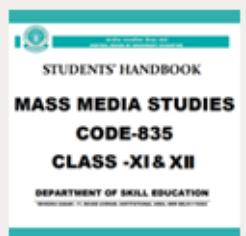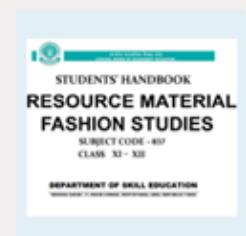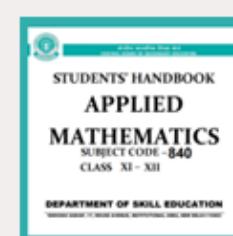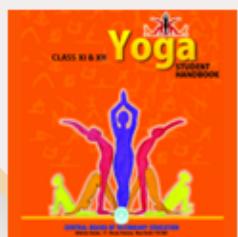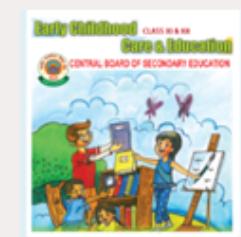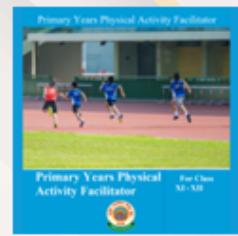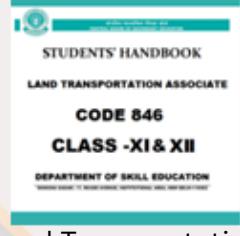
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Class 11 (Hum)

Class 12 (Sci)

Class 12 (Com)

**Class 12 (Hum)**

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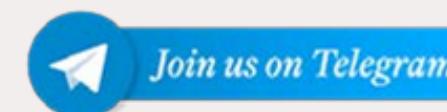
NDA, OLYMPIAD, NTSE
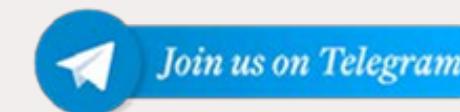
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